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TOLUCA TO HARDIN

SUPPLEMENTAL REPORT

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24 February 1964

Highway Commission
State of Montana
Helena, Montana

Gentlemen:

Presented herewith is the supplemental reconnaissance report covering the traffic analysis, the geologic and soils studies and alignment studies for the Toluca to Hardin Freeway, Interstate Project I90-9(8)471.

We have reviewed the report submitted to the commission 19 August 1963, and have studied the additional mileage as requested by the commission.

We wish to thank all parties responsible for furnishing the basic data necessary to complete this report.

Very truly yours,

THE KEN R. WHITE COMPANY

Ralph L. Menasco

Ralph L. Menasco
Project Engineer
Montana Registration
No. 2127E

RLM:pb

MONTANA HIGHWAY COMMISSION
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PUBLIC INFO.
PERSONNEL

2 April 1964

Mr. Paul Johnson
Acting Highway Engineer
Montana Highway Commission
Helena, Montana

Attention: Art Quinnell

Re: I 90-9(8) 471
KRW 3017-20

Dear Sir:

In order to complete the above referenced contract, we are submitting the information requested by you for the Line F-1. This is the alignment that connects the F Line with the A Line at Station 1800+00.

This line was eliminated from the report soon after the study started because of the high annual costs involved. The operators costs were $2,674,132 and the construction costs were $320,635, giving a total annual cost of $2,994,767. This is more than any of the Lines reported in the supplemental report. Other features of this alignment were not as desirable as the other lines. With mutual agreement, we then deleted this alignment from the supplemental report.

Thank you for your help in completing this project.

Very truly yours,

THE KEN R. WHITE COMPANY

Ralph L. Menasco

Ralph L. Menasco
Senior Engineer

RLM:pb

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INTRODUCTION

This supplemental report is a result of a request by the highway commission to The Ken R. White Company to study additional alignment on the Toluca to Hardin Project. The supplemental agreement outlines the alignment to be studied and was deemed necessary to answer questions as to possible merit of this alignment referred to as the F Line.

Montana's traffic is so light that in most instances nothing of a significant nature can be shown by the differences in total annual cost of alternate lines.

It would be reasonable to say that 5% of the total annual cost is the accuracy that one can expect from this type of study. The total annual cost for each line studied in this report is about $3,000,000. This means that unless there is a difference of $150,000 annually between lines, there is no distinct advantage. Differences of less than $150,000 would be merely an indication of a possible advantage.

The maximum difference in costs for all the lines studied was $58,000 annually. There can be no clearcut decision for any line based on annual cost alone.

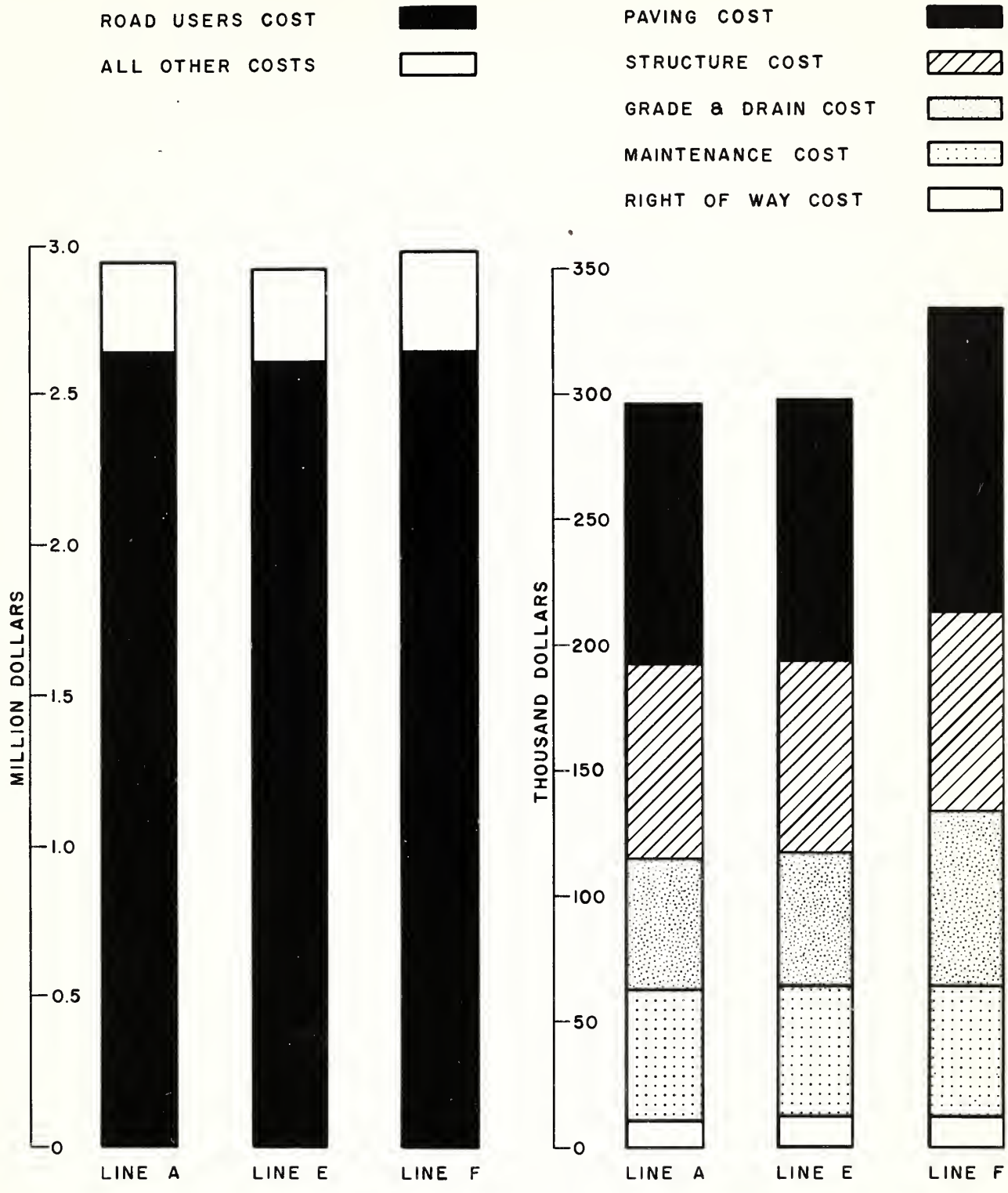
Therefore, we have based our recommendation on basic highway and city planning principles.

To illustrate how little difference there is between the alternate alignments, we have prepared the bar graphs shown in Figure I.

The Highway Engineering Hand Book printed by McGraw-Hill Book Company, Inc. makes the following statement:

"The construction of any highway, whether of primary or secondary classification, will have a definite impact on the communities, large and small, through which it passes. Studies of alternate routes must recognize this fact. In the case of limited access facilities, the effect on the community may well be the deciding factor in determining the location. Items to be considered in evaluating the effect of a highway on the community include the following:

1. Where is the location in relation to schools, churches, and public buildings?
2. Will the location pass through slum sections or other blighted areas?
3. Will the highway render service to residential, business, and industrial sections of the community?



TOTAL ANNUAL COST

ANNUAL CONSTRUCTION, MAINTENANCE, STRUCTURE & R.O.W. CONPARISON

Figure I

4. What is the assessed value of property that will be removed from the tax rolls for right-of-way purpose?
5. Does the location fit in with local master plans?
6. How will the location affect future land development and growth of the community?

Public opinion, although frequently at variance with engineering facts, must be considered and some compromise is frequently indicated."

AUTHORITY

This report has been prepared in accordance with the supplemental agreement between the Montana Highway Commission and The Ken R. White Company, formerly Ken R. White Consulting Engineers, Inc. This agreement gives the project number as I 90-9(8)471 and the name of the project as Toluca to Hardin supplemental report.

PURPOSE

The purpose of this study was to determine whether the alignment as described in the supplemental agreement had enough merit to recommend it as the alignment for this section of interstate.

BASIC DATA FOR DESIGN

1. Base Maps

The original reproducible photogrammetric maps to a scale of 1" = 400' horizontal and a contour interval of 10' were furnished by the Montana Highway Commission to this firm. The elevations shown on these maps are based on U.S.C. and G. S. datum.

Field checks were conducted to check the maps for completeness and to add major utilities, including a 12" high pressure gas line, several small low pressure gas lines and many natural gas wells.

2. Traffic Data

The Montana Highway Commission furnished this firm with the traffic data required. This data included an origin and destination study of Hardin done in 1961 showing the desires of the motorist. It also included average daily traffic (A.D.T.) counts on roads in the area.

3. Standards

Design standards were submitted by this firm to the Montana Highway Commission for their approval. The approved design standards are listed below:

a. Typical sections as shown on Sheets 2 and 3 of the plans.

b. Design conditions - flat and rolling.

c. Traffic land widths - 12 ft.

d. Design speed - 70 mph and 60 mph.

e. References:

(1) A Policy on Design Standards, AASHO.

(2) A Policy on Geometric Design of Rural Highways, AASHO.

(3) Policy on Arterial Highways in Urban Areas, AASHO.

(4) Highway Capacity Manual, U.S. Department of Commerce, Bureau of Public Roads.

(5) Field and Office Standards, Montana Highway Commission.

(6) Standard Drawings, Montana Highway Commission

(7) Standard Specification for Road and Bridge Construction, Montana Highway Commission.

(8) Road User Benefit Analyses for Highway Improvements, AASHO, 1960.

(9) Highway Traffic Estimation, The Eno Foundation for Highway Traffic Control, Saugatuck, Conn., 1956.

P A R T I

RECOMENDATIONS

A. ALIGNMENT

The Ken R. White Company recommends that the Montana Highway Commission approve the A Line as the alignment for Interstate 90 through the study area.

As stated in the introduction we have based this recommendation on the six points of consideration as given by the Highway Engineering Hand Book, plus other reasons listed below.

The points of consideration and the reasoning behind each are as follows:

1. Where is the location in relation to schools, churches and public buildings?

   The A Line is close enough to all of these facilities to give direct service. As shown on Figure IV, with some improvement of Thirteenth Street and the extension of Center Avenue by the City of Hardin, the access to any part of Hardin would be direct. The A Line would not be close enough to these facilities to create a nuisance.

2. Will the location pass through slum sections or other blighted areas?

CITY OF HARDIN
FREEWAY AND STREET PLAN

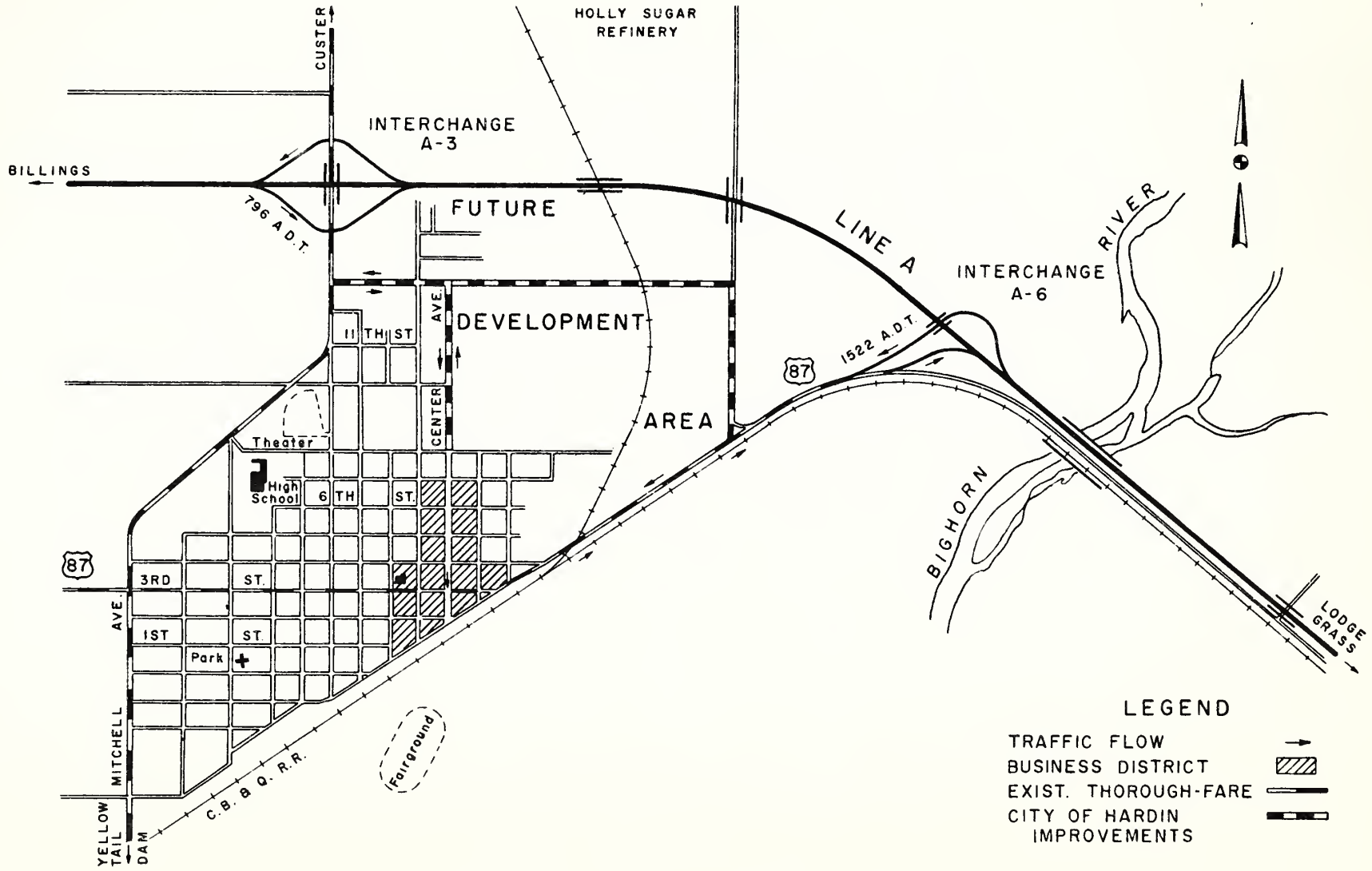


Figure IX

Hardin has no slum areas and therefore this cannot be considered as a point of judgement.

3. Will the highway render service to residential, business and industrial sections of the community?
The two interchanges as located at either side of town will provide a good circulation plan for the City of Hardin. People wanting service in Hardin will be afforded the drive through type of access without having to retrace their movements. Hardin could do many things to enhance or improve these access routes. However, the A Line Plan would function without improvements to the access routes by Hardin. The better plan is the one that allows free access to any point.

4. What is the assessed value of property that will be removed from the tax rolls for right-of-way purposes?
The right-of-way estimate furnished did not include a parcel by parcel break down of the right-of-way costs but did give a total cost. This total cost shows that any line going through the north part of Hardin is more expensive. More important, the A Line takes only property classified as farm land while the E and F Lines would take considerable subdivided parcels.

These subdivided lands will be more expensive to acquire initially and will remove properties of a higher tax base from the tax rolls.

5. Does the location fit in with the local Master Plan?

There is no Master Plan on file for Hardin. This project could have been completed much sooner and easier had there been a good, well thought out Master Plan with which to work. The A Line plan could be the basis for a Master Plan in the future because it leaves enough room to develop a plan.

6. How will the location affect future land development and growth of the community?

Hardin already has development north of the proposed E or F Lines which would create a bad situation of separation of these two areas. Once an interstate road has been constructed through an area it is very difficult to cross it with utilities. These would be needed for continued growth in the area north of the alignment. The problem of furnishing fire and police protection to an area that is separated from the rest of the community by the limited access roadway is troublesome.

In addition to the above reasons, which are concerned with the community, the following reasons are given for the selection of the A Line.

7. The A Line has the best overall alignment of all the lines studied. A tabulation of rise-fall and horizontal central angles is shown in Figure V.

8. The A Line does the least damage to the irrigated property in the vicinity of Hardin.

9. The A Line reflects a straightforward solution to a problem by the simplicity of the plan.

10. The A Line has the lowest initial cost of all the lines as shown in Table II.

11. The A Line requires no action by Hardin to make the plan operative.

12. The A Line has less conflict with existing utilities than the other lines.

B. LANEAGE

It is recommended by the Ken R. White Company that there be no decision on laneage until such time as the traffic can be expanded for the 20 year design period.

HORIZONTAL AND VERTICAL ALIGNMENT

ALIGNMENT	TOTAL RISE AND FALL (FEET)	TOTAL HORIZONTAL ANGLE (DEGREES)
LINE A	623	84°
LINE B	737	286°
LINE E	642	159°
LINE F	523	193°

SUMMATION OF RISE , FALL AND CENTRAL HORIZONTAL ANGLES OF EACH ALIGNMENT.

Figure V

C. INTERCHANGES (LINE A)

It is recommended that interchanges be constructed on Montana 47 and at Station 2185+00. These two interchanges serve the City of Hardin, as well as the farming areas to the west and southeast of the City of Hardin. Any area development, such as the completion of Yellowtail Dam, should be watched for future traffic generation and, if warranted, future interchanging recommendation.

P A R T II

TRAFFIC

A. GENERAL INFORMATION

The following basic data was made available by the Montana State Highway Commission for the traffic studies:

1. An origin and destination survey conducted in 1961 by the Montana State Highway Commission. This covered the four main highways leading into Hardin: namely, U.S. 87 east and west of Hardin, State Route 47 north of Hardin, and FAS 313 south of Hardin.
2. 1958 and 1975 average daily traffic for various county roads and main highways around Hardin.
3. Information pertinent to the Interstate:

Directional Distribution	55%
Truck Percentages:	
West of Hardin	15%
East of Hardin	12%
DHV Factor	13%

B. PROCEDURES

In addition to the zones used in the 1961 origin and destination survey, other zones and centroids were introduced around the City of Hardin as follows:

1. Considerable local traffic was evident in the area of the three county roads immediately west of Hardin. In order to assign this traffic, Zone "A" was established using a point midway of the three roads as the centroid.
2. Zones "B", "C" and "D" east of Hardin were established and their centroids so located that a common point on intersecting roads was available for all alternate studies.
3. Centroids in Zones 301, 302 and 303 were established with the aid of aerial photography, local inspection and probability of growth factors.

To determine percentages of traffic desire from the various zones outside the city, "T" intersection distribution was utilized from average daily traffic furnished by the Highway Commission.

By utilizing the 1961 origin and destination data and applying the values percentagewise to the given 1958 and 1975 average daily traffic, it was possible to determine traffic volumes for all interzone travel throughout the study area. Percentage of distribution for Zone "A" was derived from the origin and destination station west of Hardin, and for zones "B", "C" and "D" from the origin and destination station east of Hardin.

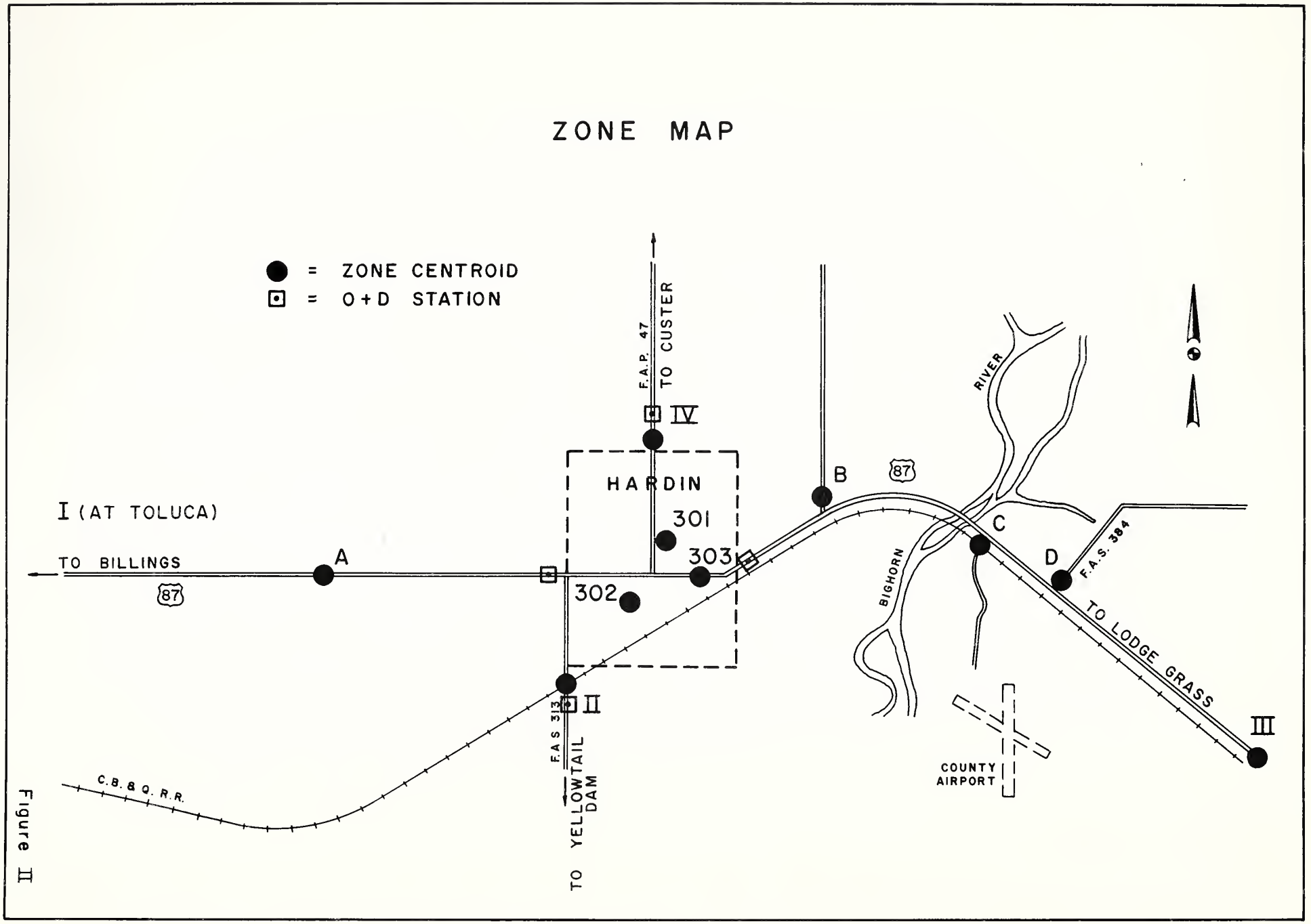
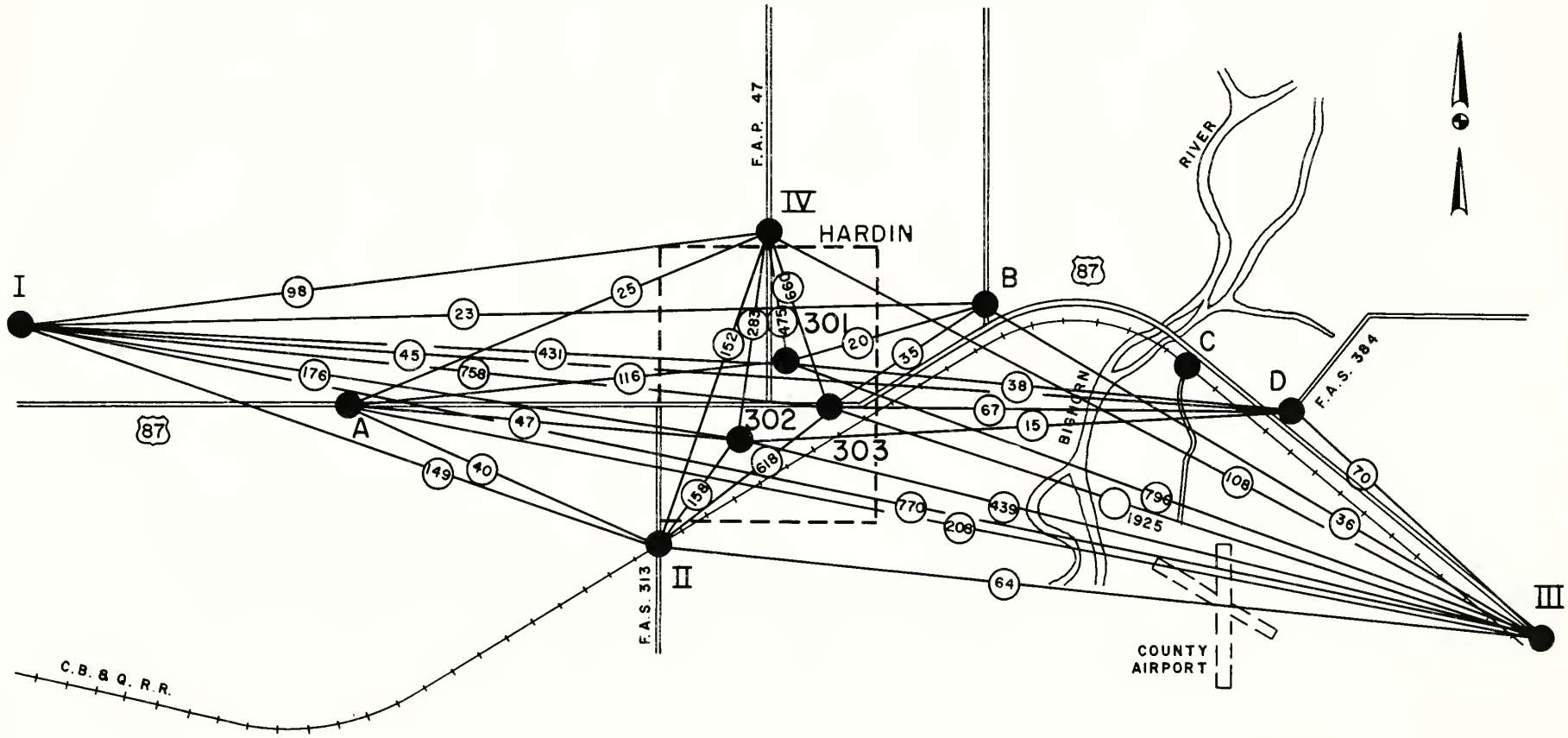

ZONE MAP
= ZONE CENTROID
= O+D STATION
F.A.P. 47
TO CUSTER
IV
HARDIN
301
303
302
I (AT TOLUCA)
TO BILLINGS
87
A
B
87
RIVER
C
D
F.A.S. 384
BIGHORN
TO LODGE GRASS
III
II
F.A.S 313
TO YELLOWTAIL DAM
C.B. & Q. R.R.
COUNTY AIRPORT

Figure II

1975 TRAFFIC DESIRE DIAGRAM



NOTE: DESIRE LINES 10 ADT AND LESS NOT INDICATED.

Figure III

Zone locations are shown on Figure II, while the traffic desire diagram for the study is shown on Figure III. Schematics of the alternates and interchange locations are shown on Figure IV.

C. TRAFFIC ASSIGNMENT

Assignment of traffic was made by employing the method used by the California Division of Highways which is described in "Highway Traffic Estimation" by Robert Schmidt and M. Earl Campbell in The Eno Foundation for Traffic Control, 1956. Logic was used in determining the routing of all trips between zones with three types of routings being considered:

1. Trips over existing streets and highways.
2. Trips avoiding use of the freeways referred to as "Freeway Haters".
3. Trips utilizing a maximum of freeway travel referred to as "Freeway Users".

Attempts to obtain travel speeds by the "floating car" method did not materialize, due to sparse traffic. The speeds used in the study were obtained from information gathered by the Montana Highway Commission from speed studies in the State and correlation of posted speeds on the city streets and roads with AASHO criteria.

By comparing each interzone movement using existing streets with the "Freeway Users" trip or comparing "Freeway Haters" trips with "Freeway Users" trips, whichever is applicable, the differences in time and distance were obtained. Logic was used in each interzone movement so that distorted and unreasonable trips were not used. The following formulas were applied to find the percentage diversion of trips to freeways and ramps:

$$P = 50 + \frac{50(d + 1/2t)}{[(d - 1/2t)^2 + 4.5]^{1/2}}$$

Where p = Percent assignment to the Freeway

d = Distance saved

t = Time saved

or if $p < 50$ and $L < 2.0$ miles, the following modification is applied:

$$p_1 = p + (p-50) \times (1.5 - 0.75L)$$

Where p_1 = Modified percent assignment.

p = Original percent assignment.

L = Length of Freeway travel on Freeway routing minus length of Freeway travel on basic or existing routing.

Penalties of 0.1 mile and 0.2 minute were added for each ramp used in each interzone trip to compensate for circuitry of travel and slower speeds on ramps.

It should be noted that when a frontage road paralleled the

Interstate for a considerable distance and where there was a choice of routings, logically, the traffic was diverted to the Interstate routing.

Summarizing the data thus obtained, flow diagrams of traffic on the Interstate and interchanges were prepared. These are shown on Figures V through XVII.

D. USER'S COST

Mileages for the various speeds used on freeway, city, county secondary and primary roads were tabulated. Unit prices of travel, adjusted for gradient, curvature and higher gasoline prices in Montana, were established with the aid of the AASHO publication entitled Road User Benefit Analyses for Highway Improvements. The road user's costs were calculated for a 20 year period from 1965 to 1985. The road user unit prices are listed below:

Type of Facility	Operation	Grade - %	Cost per Mile
Interstate:			
* 4 lane, divided	Free	0-3	$.0936
* 4 lane, divided	Free	3-5	.0963
* 2 lane	Free	0-3	.0973
Primary - 2 lane	Normal	0-3	.1035
County Road - 2 lane	Gravel	0-3	.1250
City - 2 lane	Restricted	0-3	.1406

* For estimating purposes.

The unit prices multiplied by the total mileage plus a penalty cost for an intersection delay (downtown stop light) established the operating cost. It is to be noted that travel costs for the study area were totaled for all interzone movements in the area. Road user's costs combined with construction, maintenance and right-of-way costs determined the user's cost for each alternate. Summaries of these costs are shown on Table II of this report.

E. INTERCHANGE JUSTIFICATION

Table I indicates the annual savings by using the interchange locations indicated for the various alternates shown on the Plan Sheets, 1-17, in the back of the report. Justification is shown for the interchanges which were questionable as to their value.

F. LANE REQUIREMENTS

The following criteria was used for determining laneage requirements for estimating purposes.

1. Running Speed - In excess of 50 mph (based on information from Highway Commission speed studies in Montana).

2. Capacity - Based on Highway Capacity Manual, U.S. Department of Commerce, Bureau of Public Roads.

Six hundred passenger cars per hour (p. 46 of referenced Manual).

a. Correction with 12% trucks level terrain (p. 56 of referenced Manual).

$$600 \times 0.89 = 534$$

b. Correction with 15% trucks level terrain (p. 56 of referenced Manual).

$$600 \times 0.87 = 522$$

c. Correction with 12% trucks rolling terrain (p. 56 of referenced Manual).

$$600 \times 0.75 = 450$$

TABLE I

ITEM	WITH INTERCHANGE A-6		WITHOUT INTERCHANGE A-6	
	TOTAL COST	ANNUAL COST	TOTAL COST	ANNUAL COST
Grading	$100,813	$ 5,877	$ 44,258	$ 2,580
Drainage 2-Lane			6,143	358
Drainage 4-Lane	14,520	847		
Base 2-Lane			25,266	2,023
Base 4-Lane	45,006	3,609		
Surfacing 2-Lane			34,168	2,740
Surfacing 4-Lane	84,978	6,815		
Structures	930,003	50,964	444,891	24,380
Maintenance		3,330		2,775
Operators Cost		2,638,214		2,695,047
Total Annual Cost		$2 709,656		$2,729,903

Total Annual Saving $20,247

Grading, Drainage, Base, Surfacing and Maintenance Comparison are from Station 2185+00 to Station 2243+00. Structures that are compared are A-6, A-7 and A-8.

F-3 INTERCHANGE LINE F
2122+00

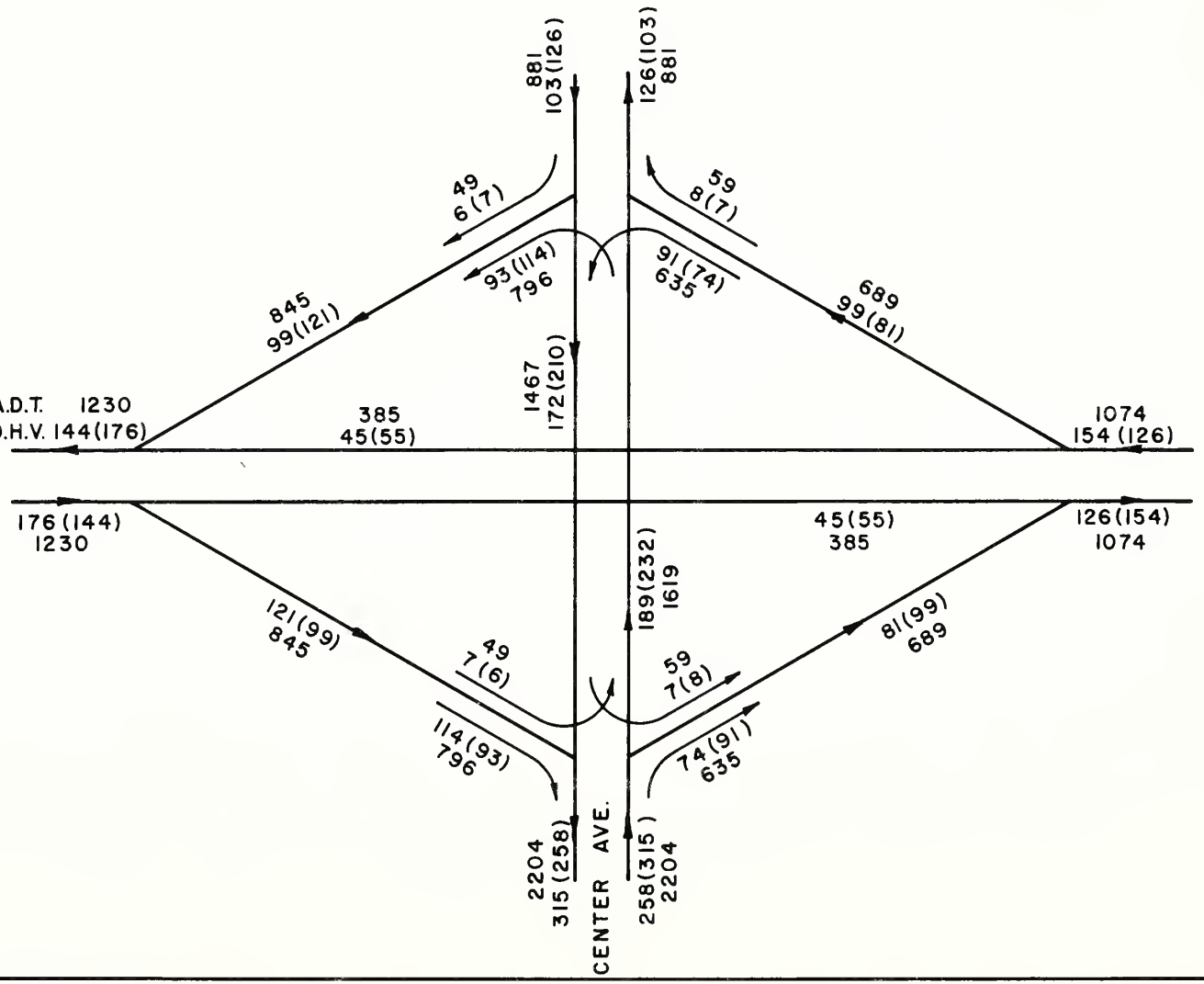


Figure VI

E-6 INTERCHANGE LINE E *

2171+00

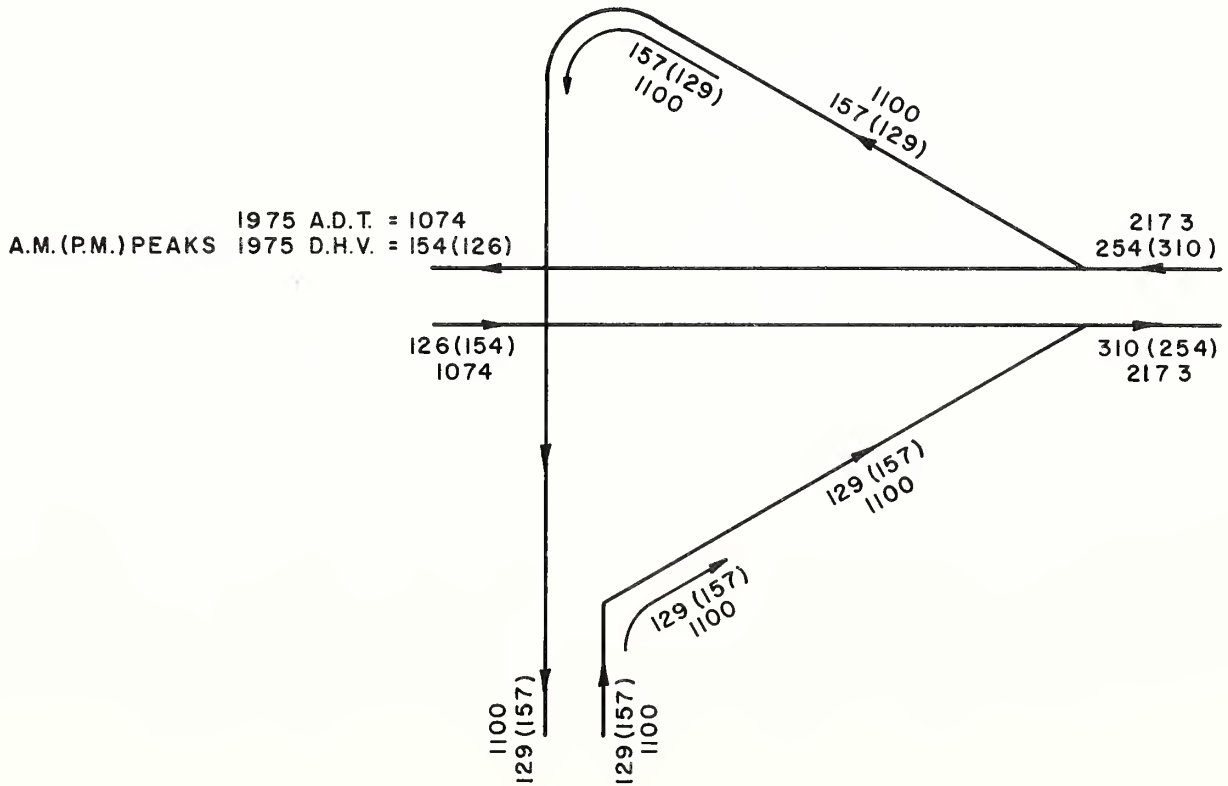


Figure VII

* WITH F-3 INTERCHANGE AT CENTER AVE.

P A R T III

ALTERNATE DESCRIPTIONS AND COST DATA

A. A LINE

The A Line plans are shown in the back of the report. Beginning at Station 1530+00 and proceeding east along a tangent to Station 1750+00, the A Line passes through rolling ranch land. Moderate cut and fill sections will be encountered in this region. As discussed later in the soils and geological section, the soils of this area are a problem due to their expansive nature. This problem, as related to the soils, is held to a minimum by keeping the roadway high up on the hills to the north where the soils are better than those in the lower elevations to the south. By cutting in the better soils and filling in the lower areas a more stable subgrade can be built.

At Station 1584+00 and Station 1736+00 simple span drainage structures were utilized to take care of the drainage areas that cross the centerline. For estimating purposes these structures were made comparable in size to the existing structures on U.S.87 which serve the same drainage areas.

The only grade on the A Line that approaches three percent is in this section west of Hardin and is a 2.93 percent grade between Station 2030+00 and Station 2040+00.

From Station 1750+00 the line bears slightly north and is again a tangent to Station 2025+00. This location keeps the alignment in the higher and better soils. The alignment traverses into the cultivated dry land farming at approximately Station 1840+00 which is on the bench west of Hardin. It is proposed that upon completion of the Yellowtail Dam that this area will be irrigated by water furnished by that dam.

A grade separation for the county road will be provided at Station 1919+00 to minimize long trips for farm machinery, farm cars and traffic moving to the northwest. The system of County Section Line roads will serve as frontage and access roads throughout this area.

At Station 2025+00 a grade separation is proposed which will be required to provide access for the area to the north.

From Station 2025+00 to Station 2149+00 the alignment again goes due east along the midsection line to minimize property damage to the irrigated land. At Station 2037+00 it will be necessary to have a simple span structure across the Two Leggins Canal. The canal serves the irrigated area west of the City of Hardin. All lateral ditches in the area are privately owned, so final design plans will have to include restoration of any ditches disturbed by the construction of the roadway.

At Station 2100+00 a full diamond interchange is proposed. The interchange will service the area north of Hardin along FAP 47, as well as Hardin proper. Route 47 will afford a direct connection to proposed Interstate 94 to the north. No justification was deemed necessary for this interchange due to its location and the primary route it intersects.

From this interchange the alignment passes close to the north city limits of the City of Hardin and crosses the C.B. & Q. Railroad's north spur line. This location was chosen to pass as close to the city as possible without disturbing existing developments and allow for the continued expansion of the residential area already in progress. It would also cause fewer utility problems for the existing and future residential developments.

From Station 2149+00 to Station 2200+00 the alignment swings southeast to become parallel with and adjacent to the existing primary route U.S. 87.

At Station 2153+00 a grade separation is proposed. This facility will serve traffic movements between the area southeast of Hardin and the Holly Sugar Refinery. It will also allow for movement of farm equipment across the interstate in the farming area between the Big Horn River and the City of Hardin.

From Station 2200+00 to the east end of the project at Station 2336+00, the alignment is parallel along the east side of existing U.S. 87. At Station 2185+00, Interchange A-6 is proposed. This facility will service traffic to and from the east desiring access to Hardin. It provides a direct route to the city and cuts off approximately one-half mile of additional travel for the public. Justification is shown in Table I, Part II.

From Station 2150+00 to Station 2183+00 a frontage road is required to serve an isolated property.

The alignment crosses the Big Horn River at Station 2210+00. This crossing, which is just downstream from the present bridge, is the most logical since the channel widens downstream and more expense would be necessary at other locations.

A grade separation is proposed at Station 2243+50. Traffic from FAS 384 will cross under the interstate roadway and use existing U.S. 87 for directional travel.

From Station 2217+00 to Station 2336+00, a frontage road is proposed in order to serve property owners on the east side of the interstate.

The grade line will be held comparatively high throughout this area to protect the interstate from flooding and also to keep above the high water table as described in the soils and geological section.

U.S. 87 will be left in place connected to the existing frontage road along the west side of the present Interstate 90 in order to serve the property on the west side of the C.B. & Q. Railroad.

B. E LINE

The E Line plans are shown in the back of the report. The E Line has the same alignment as the A Line from Station 1530+00 to Station 2050+00. At this point, the E Line swings southeast in an effort to better serve Hardin. This alignment cuts some irrigated farmland diagonally, but the attempt was made to hold damage to separated properties to a minimum.

The full diamond interchange at Station 2104+50 will service the area north of Hardin along FAP 47, as well as Hardin proper. Route 47 will afford a direct connection to proposed Interstate 94 to the north. No justification was deemed necessary for this interchange due to its location and the route it intersects.

From the interchange east to approximately Station 2115+00 this alternate will cause damage to improved properties and sever a developing residential area from the remainder of Hardin. Every attempt was made to minimize this damage.

At Station 2146+00 the alignment crosses the C.B. & Q. Railroad and at Station 2157+00 a county road is crossed with a grade separation. This grade separation will allow traffic traveling between the area southeast of Hardin and the Holly Sugar Refinery to pass under the Interstate.

A directional interchange is proposed at Station 2170+00 with existing U.S. 87. This facility will service traffic to and from Hardin from the east. It provides a more direct route into the city and cuts off approximately 1/2 mile of additional travel for the public. Justification is shown in Table I, Part II.

Beyond the interchange the alignment heads southeast and becomes parallel to U.S. 87 at Station 2200+00. It then has a common alignment with A Line to the end of the project where it connects with existing Interstate 90.

C. F Line

The F Line plans are shown in the back of this report. Beginning at Station 1530+00 it proceeds east along the same alignment as the A Line to Station 1590+00. At this point the F Line swings southeast and follows the present travelway to Station 1675+00. The alignment then proceeds due east and in doing so, traverses an area of very poor soil conditions. This section is spotted

with small farm ponds and low, poorly drained areas usually found in connection with them. This section of roadbed would be very expensive to construct for several reasons.

The amount of earthwork required would be excessive, 40,000 cubic yards per mile more than the A Line. This is necessary to avoid the expansive shale lying at the lower elevations.

The pavement design would require double the amount of base material required for construction of the A Line. This again is due to the extremely poor soils condition.

Pavement, ditch and side slope maintenance would be a continual problem because of this unstable soil condition.

At approximately Station 1860+00 the F Line would require special consideration to avoid electrical transmission lines in the area from 1700+00 to Station 1910+00. These double line transmission lines would be expensive to relocate.

At Station 1870+00 the F Line picks up, and runs parallel to, a country road. This road would serve as a frontage road on the north side of the interstate. The grade separation at Station 1923+00 would be required to serve the area to the northwest as well as allow farm machinery to cross the interstate without being forced out of direction. This grade separation of the

F Line would require realignment of the county road for 1000 feet to match grade with the crossroad. This would not be required on the A Line.

The grade separation at 2029+00 is required to serve the cemetery and the farming area to the north. At approximately Station 2040+00 the F Line would require the moving of a home on the south side of the county road. This would be necessary in order for the interstate to clear the cemetery.

At Station 2015+00 the alignment would close off an existing local road serving 4 dwellings. These homes would still have access, but not from the north.

At Station 2080+00 the F Line turns north east and crosses Montana 47 at the same places as the E Line. Because of heavy truck traffic moving to the Holly Sugar Refinery, a grade separation would be required on this State Road.

At this point the alignment follows the E Line of our previous report to the Big Horn River Crossing where the E and F Lines join with the A Line.

The extension of Center Avenue and the improvement of an east-west street to connect Center Avenue extention with Montana 47 would be required if the northern part of Hardin is to develop in an orderly manner.

These improvements to local streets should be the responsibility of the City of Hardin.

The plan of putting an interchange at the extensions of Center Avenue on the F Line would not promote orderly growth. It would throw up a barrier to utility expansion. The same results could be achieved by the use of improved local streets and locating the interchange at FAP 47. To improve local streets as access routes would give Hardin the opportunity to develop its own transportation system with its own controls.

The alignment crosses the C.B. & Q. Railroad spur track to the Holly Sugar Refinery at Station 2148+00 and, while still decending, crosses the county road one half mile east of Hardin. This road should be kept open to allow continuity of traffic flow.

The interchange at Station 2171+00 is a directional type that serves traffic from the southeast to Hardin. This interchange would allow cars from Hardin to get on the interstate and proceed south. It would also allow cars from the south to leave the interstate and enter Hardin.

At this point the E and F Lines join the A Line.

D. ESTIMATING PROCEDURES

1. Grading Quantities

The Montana Highway Commission furnished aerial maps with a horizontal scale of 1" = 400' and a 10' contour interval. This mapping was used as a basis for cross sections which were taken at appropriate intervals. End areas and volumes were then calculated.

2. Drainage

The cost of drainage structures 72" in diameter and under were estimated as an average cost per mile from figures furnished by the Montana Highway Commission for the year 1959. The 1959 costs were adjusted to present by using the Engineering News Record Index of June 20, 1963. Larger drainage structures were computed separately.

3. Surfacing

Surfacing costs were estimated by the use of cost-per-mile of roadway and updated to the present.

4. Structures

All structures were estimated by use of the Deck Area Method, with allowances for different site problems.

5. Interchanges

The interchange costs were estimated after the studies as to type and after general geometrics were completed. These costs are based on typical interchange costs for the particular type of interchange as constructed by the Montana Highway Commission and include the guard rail, curbs, and signing. The structures for the interchanges were estimated separately.

6. Right-of-Way Costs

Right-of-way costs were furnished by the Montana Highway Commission from ownerships furnished by this firm, and include only the cost of the acreage taken. However, it is expected that damages will be very nearly the same for all lines.

7. Summary of Total Costs

An interest rate of 5% was used for this study. The number of years of average life for each item of construction cost is shown on Tables VIII, IX and X. Maintenance costs for the various road types are shown on Tables VIII, IX and X. Costs of travel on the different types of roads are shown in Part II - Traffic.

Individual bridge costs are tabulated in Table B-I of Part IV - Bridges.

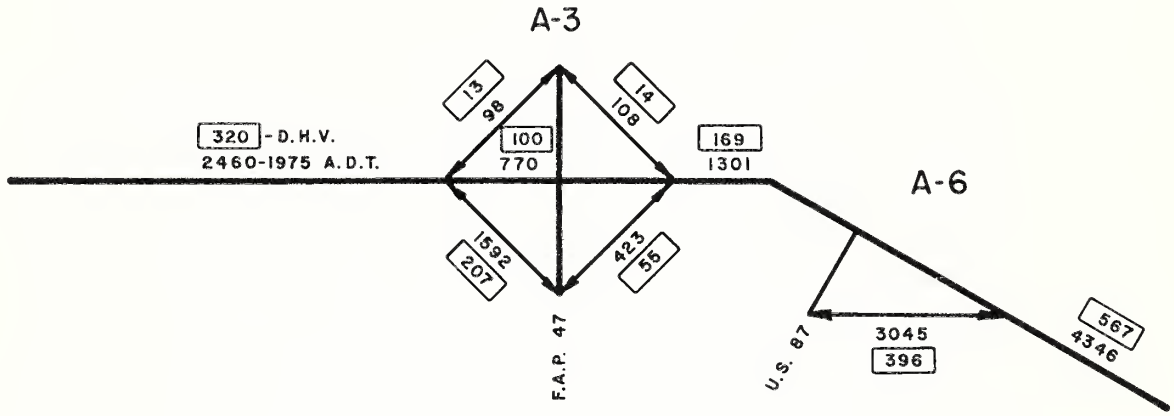
Table II, which follows, gives a detailed comparison of construction costs.

TABLE NO. II

COMPARISON OF TOTAL AND ANNUAL
CONSTRUCTION COSTS

ITEM	LINE A		LINE E		LINE F	
	TOTAL	ANNUAL	TOTAL	ANNUAL	TOTAL	ANNUAL
MAIN LINE						
Clearing & Grubbing	55,946	3,261	55,946	3,261	56,143	3,273
Grading	582,321	33,949	579,688	33,796	855,115	49,853
Drainage	105,344	6,141	107,193	6,249	107,492	6,267
Surfacing	537,303	43,092	543,277	43,572	544,939	43,704
Base Material	460,875	36,962	465,535	37,337	596,467	47,837
Seeding & Mulching	43,963	2,563	43,879	2,558	43,812	2,554
Miscellaneous	156,246	12,532	144,355	11,577	164,707	13,210
FRONTAGE ROADS						
Grade & Drain	46,007	2,683	48,131	2,807	53,326	3,109
Base Material & Surfacing	38,018	3,048	39,774	3,188	44,066	3,534
INTERCHANGES & GRADE SEPARATIONS						
Grading	75,252	4,388	75 252	4,387	96,365	5,618
Base Material & Surfacing	91,459	7,335	91,459	7,335	108,928	8,736
Structures	1,409,789	77,256	1,393,878	76,385	1,445,578	79,218
Miscellaneous	24,806	1,989	24,806	1,989	25,438	2,040
RIGHT OF WAY	202,700	11,108	219,950	12,053	219,950	12,053
TOTAL	$3,830,029	$246,307	$3,833,123	$246,494	$4,362,326	$281,006

TWO-WAY AVERAGE DAILY TRAFFIC
LINE A



SUMMARY COSTS
LINE A

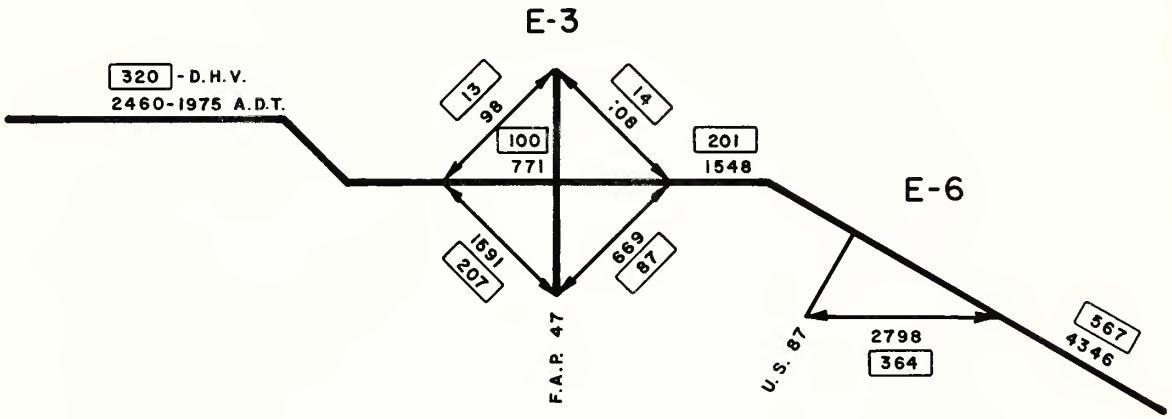
ITEM	ESTIMATED LIFE YEARS	TOTAL COST DOLLARS	*K	ANNUAL COST DOLLARS
Base, Surfacing etc.	20	1,308,707	0.0802	$ 104,958
Grading & Drainage	40	908,833	0.0583	52,985
Major Structures	50	1,409,789	0.0548	77,256
Right of Way	50	202,700	0.0548	11,108
Maintenance: Interstate 4 Lane		2.671 Mi. @ $ 3000 / Mile		8,013
Interstate 2 Lane		12.595 Mi. @ $ 2500 / Mile **		31,488
Primary 2 Lane		15.348 Mi. @ $ 500 / Mile		7,674
Frontage 2 Lane		4.526 Mi. @ $ 500 / Mile		2,263
Interchange Ramps		1.989 Mi. @ $ 1500 / Mile		2,984
Operating Cost				2,644,423
			Total	$ 2,943,152

* K = Capital Recovery Factor

** Includes 3.649 Mi. Double Maintenance

Figure VIII

TWO-WAY AVERAGE DAILY TRAFFIC
LINE E



SUMMARY COSTS
LINE E

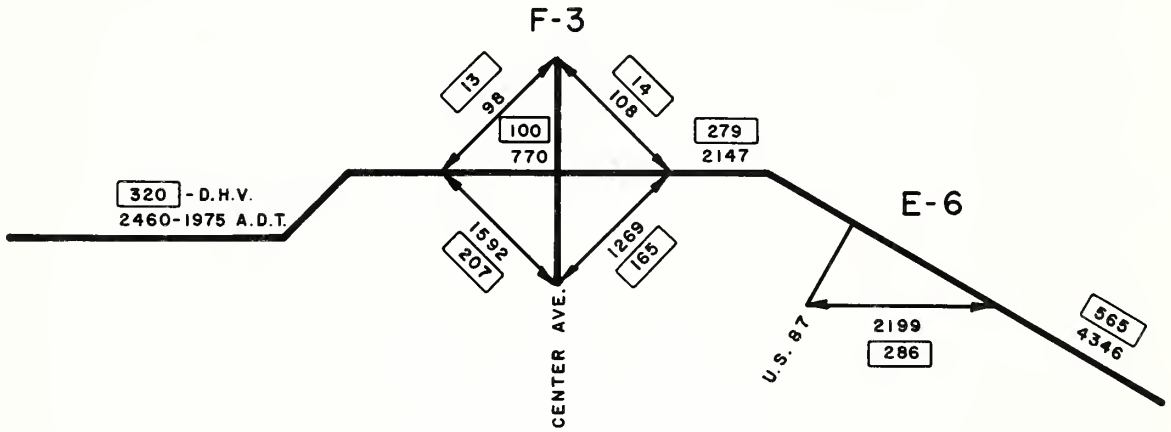
ITEM	ESTIMATED LIFE YEARS	TOTAL COST DOLLARS	*K	ANNUAL COST DOLLARS
Base, Surfacing etc.	20	$ 1,309,206	0.0802	$ 104,998
Grading & Drainage	40	910,089	0.0583	53,058
Major Structures	50	1,393,878	0.0548	76,385
Right of Way	50	219,950	0.0548	12,053
Maintenance: Interstate 4 Lane		2.879 Mi. @ $ 3000 / Mile		8,637
Interstate 2 Lane		12.310 Mi. @ $ 2500 / Mile	**	30,775
Primary 2 Lane		15.348 Mi. @ $ 500 / Mile		7,674
Frontage 2 Lane		4.735 Mi. @ $ 500 / Mile		2,368
Interchange Ramps		1.989 Mi. @ $ 1500 / Mile		2,984
Operating Cost				2,612,514
			Total	$ 2,911,446

* K = Capital Recovery Factor

** Includes 3.649 Mi. Double Maintenance

Figure IX

TWO-WAY AVERAGE DAILY TRAFFIC
LINE F



SUMMARY COSTS
LINE F

ITEM	ESTIMATED LIFE YEARS	TOTAL COST DOLLARS	*K	ANNUAL COST DOLLARS
Base, Surfacing etc.	20	$ 1,484,545	0.0802	$ 119,061
Grading & Drainage	40	1,212,253	0.0583	70,674
Major Structures	50	1,445,578	0.0548	79,218
Right of Way	50	219,950	0.0548	12,053
Maintenance: Interstate 4 Lane		2.879 Mi. @ $ 3000 / Mile		8,637
Interstate 2 Lane		12.440 Mi. @ $ 2500 / Mile * *		31,100
Primary 2 Lane		15.348 Mi. @ $ 500 / Mile		7,674
Frontage 2 Lane		5.246 Mi. @ $ 500 / Mile		2,623
Interchange Ramps		1.989 Mi. @ $ 1500 / Mile		2,984
Operating Cost				2,639,178
			Total	$ 2,973,202

* K = Capital Recovery Factor

* * Includes 3.649 Mi. Double Maintenance

Figure X

P A R T I V

BRIDGES

A. GENERAL

Bridge investigations were performed on all sites for each line study. As the purpose of this report was to determine the most feasible route for Interstate 90, these investigations were confined, in extent, to determine relative total bridge costs only. Since the type and number of crossings were approximately the same for each line, no attempt was made to determine the most economical structure type or to evaluate other details which would not affect the relative total costs.

Sheet No. 17 of the plans illustrates the basic layout criteria used in determining bridge widths and approximate lengths. Total estimated bridge costs are tabulated in Table B-1. The estimated cost per square foot was varied to allow for heavy skew angles, excessive height and other unusual factors which would affect the bridge cost.

B. BIG HORN RIVER STUDY

Preliminary hydraulic studies of the Big Horn River have been accomplished as an aid in evaluating the structure

costs for the two alternate crossings. Approximately 33 miles upstream from the proposed crossing, and currently under construction, is the Bureau of Reclamation's Yellowtail Dam. The dam is scheduled for completion in 1965, and based upon a 50 year frequency, will have a design flood control release of 20,000 c.f.s.

The watershed area between Hardin and the dam is approximately 1,115 square miles. To determine runoff from this area, methods and charts contained in the U.S. Department of Interior, Geological Survey publication titled Floods in Eastern Montana Magnitude and Frequency were used. This report was prepared in cooperation with the Montana State Highway Commission in May of 1958. An additional 50 year discharge of 9,550 c.f.s. was determined, and when added to that of the dam, yielded a design discharge of 29,550 c.f.s. at the bridge site.

The Geological Survey operated a gaging station near Hardin at the present Chicago, Burlington and Quincy Railroad bridge from 1904 through 1917 and at the present U.S.87 Highway bridge from 1918 to 1933. These records indicated that a mean velocity of approximately 7 f.p.s occured during discharges of 28,000 to 30,000 c.f.s. If this velo-

city is still valid a waterway area of 4,200 square feet would be required. This was the basis used for determining the approximate bridge lengths required for each study line.

C. BRIDGES - ALTERNATE LINES

1. A Line

This route requires 8 bridge sites of normal proportions plus the long crossing of the Big Horn River. Of the 9 locations, Sites A-1 through A-6 are single bridges and Sites A-7 through A-10 are twin bridges.

2. E Line

Bridge requirements for this line are essentially identical to that of the A Line. Sites 1, 2 7, 8, and 9 are at the same location for both lines. Sites 3, 4, 5 and 6 provide crossings for the same features at different locations.

3. F Line

Bridge requirements for the F Line are essentially identical to the E Line. Sites E-3, 7, 8 and 9 are at the same location for both lines. Sites 1 and 2 provide crossings for the same features at different locations. Site F-3 is the structure at the extension of Center Avenue. F Line has one more structure than the A or E Line.

TABLE B-1

ESTIMATED BRIDGE COSTS

	Site No.	Length Feet	Width Feet	Area Sq. Ft.	Est. Cost per Sq. Ft.	Cost
LINE A	A-1	178	31	5,518	$10.00	$ 55,180
	A-2	110	47	5,170	10.00	51,700
	A-3	174	31	5,518	10.00	55,180
	A-4	163	47	7,661	11.00	84,271
	A-5	186	31	5,766	10.25	59,102
	A-6	204	27	5,508	10.25	56,457
	A-7	615	62	38,130	20.00	762,600
	A-8	132	82	10,824	10.25	110,946
	A-9	189	82	15,498	11.25	174,353
					Total Line A	$1,409,789
LINE E	E-1	178	31	5,518	$10.00	$ 55,180
	E-2	110	47	5,170	10.00	51,700
	E-3	111	47	5,217	10.00	52,170
	E-4	148	47	6,956	11.00	76,516
	E-5	112	47	5,264	10.25	53,956
	E-6	204	27	5,508	10.25	56,457
	E-7	615	62	38,130	20.00	762,600
	E-8	132	82	10,824	10.25	110,946
	E-9	189	82	15,498	11.25	174,353
					Total Line E	$1,393,878
LINE F	F-1	178	31	5,518	$10.00	$ 55,180
	F-2	110	47	5,170	10.00	51,700
	E-3	111	47	5,217	10.00	52,170
	F-3	110	47	5,170	10.00	51,700
	F-4	148	47	6,956	11.00	76,516
	F-5	112	47	5,264	10.25	53,956
	F-6	204	27	5,508	10.25	56,457
	F-7	615	62	38,130	20.00	762,600
	F-8	132	82	10,824	10.25	110,946
	F-9	189	82	15,498	11.25	174,353
					Total Line F	$1,445,578

P A R T V

SOILS AND GEOLOGY

A. INTRODUCTION

Geology has an important effect on the choice of alternate road alignments, especially in the western half of the project. A preliminary appraisal of the effect of the subsoil on bridge foundations and pavement section and thickness is given. Regional geology and subsurface soil conditions are discussed below and shown on Figure S-1 and Table S-1.

B. GEOLOGY

The entire project is underlain by Cretaceous shale hundreds of feet thick. In the western half of the project shale outcrops are covered by an overburden only two or three feet thick. The shale beds are horizontal or have a very slight dip. There are no igneous or metamorphic rock in the vicinity. In the river valleys, wide channels were eroded by the Big Horn and Little Big Horn and 15 to 20 feet of alluvium has been deposited. The Little Big Horn River has changed its course many times leaving numerous ox-bow ponds as remnants of its previous channel. The ox-bows are filled with water and their bottoms are covered with thin, marshy, deposits. About 100 feet of shale is exposed on the high bluff just east of Hardin. This bluff was protected from

erosion by a cap of terrace gravels about 25 feet thick.

Hardin townsite is located on the first terrace above the Big Horn River. Soils comprising the valley and this terrace are principally silty sands with occasional sandy gravel deposits at depth. Two miles west of town and about 70 to 80 feet higher in elevation, there is a second river terrace comprised principally of lean clay. Small gravel deposits are currently being mined around the perimeter of the second terrace. Farther west, beginning about Station 1900+00 on the A Line and 1850+00 on the B Line, Cretaceous shale formations rise within a few feet of the surface and this situation continues to the west end of the project. The term shale is used here to indicate an ancient deposit of clay which has been heavily precompressed by thousands of feet of overburden in the geologic past. This pressure has compacted it heavily and squeezed out a large percentage of moisture. The material still possesses many of the qualities of a fat clay, however. Compared to ordinary soils, shale is relatively hard, but it is not in the same class with hard crystaline bedrock. Cretaceous shales are divided geologically into two members with significantly different engineering characteristics. The lower member, the Niobrara, is a fat black shale clay containing several seams of bentonite.

The Niobrara has a high plasticity index and is subject to large changes in volume following changes in moisture content. Black Niobrara shale is overlain by the Telegraph Formation, a sandy bluff colored shale. The Telegraph has a lower plasticity, its potential volume change is considerably less, and it is not known to contain bentonite. See Figures S-2 and S-3 for the results of swell tests on the shale formations.

More erosion resistant Telegraph Creek Formation makes up most of the higher ground of Lines A and B, thus cuts are principally through the Telegraph Formation and Black Niobrara shale is exposed only in the valleys and draws. The coincidental lines from Station 1600 to the west are underlain by Niobrara shale.

C. ROADWAY AND PAVEMENT

Small portions of the alignments are in expansive black Niobrara shale on Line B from Station 1850 and part of Line A from Station 1900 to the west to Station 1650 and present serious problems for construction of high type highway pavements requiring deep cuts and strict surface tolerances. From Station 1650 west all of the cuts will be in the Niobrara

shale. It is very difficult to prevent this shale from swelling. In the deep cuts up to one foot of heave is anticipated. A large decrease of shear strength accompanies expansions, necessitating a thick pavement section to prevent shear failures. These undesirable characteristics of the prospective subgrade plus a heavy concentration of sulfate salts (which attack concrete) practically preclude consideration of a rigid Portland Cement Concrete pavement. The flexible qualities of asphalt concrete allow it to conform to an irregular surface. Exceptionally deep subbases will be required over Niobrara shale.

Heaving is not too apparent on existing U.S. 87 because there are only a few shallow cuts and the road was not built to strict surface tolerance, thereby obscuring its effect. Shale, in situ, in deep cuts expands considerably more than the same material placed in embankments. This is particularly true if abundant water is added during compaction of the embankments.

Slope failures are frequently found in deep cuts in shales, caused by a gradual softening of the shale through percolation of the water in cracks and fissures. Existence of bentonite seams vastly increases the chances of slides. From

this standpoint the Telgraph Creek Formation, along the alternates shown, is more desirable than the Niobrara Formation to the south.

After leaving the shale uplands east of Station 1900 Line A and 1850 Line B, no special roadway problems are anticipated. Subgrades are ordinary lean clay and silty sand. Line B cuts through the high bluff, east of the Big Horn, and there are numerous landslides visible along both sides of this bluff. Some have been caused simply by the rivers undercutting the toe of the slope, producing a slide. Others have been caused by a gradual softening of the very stiff shale, due to infiltration of water from above, which has reduced the shear strength until the slope is no longer stable. The former slides can be prevented in the cut by merely laying the side slopes back on an angle somewhat less than the natural angle of repose. The latter slides, due to softening, cannot be prevented so easily; however, the evidence available now indicates that the particular condition required for softening occurs south of the airport located on the bluff southeast of Hardin, but probably not to the north.

Finished grades of both lines in the valley of the Little Big Horn should be kept high to provide adequate freeboard above

the shallow water table. Silty sand soil predominates and there are no other special problems foreseen in this valley.

D. BRIDGE FOUNDATIONS

Valley fills of the Little and Big Horn Rivers are from 15 to 20 feet thick and consist of sand, gravel and silt with black shale underlying the valley fills. Pile foundations for all bridges located in both valleys are indicated by erosion considerations and by the relatively shallow depth to a competent shale bearing strata.

There appears to be a serious erosion problem on the east abutment of the Big Horn crossing Line B, where the river is actively undercutting the bluff.

Grade separations, located on the first and second terraces west of Hardin, can probably be founded on shallow footings bearing on alluvium. Grade separations on shale beds farther west will be founded on the shale using shallow foundations (pads or short piers) designed to exert large dead load pressures to prevent expansion.

E. SUMMARY

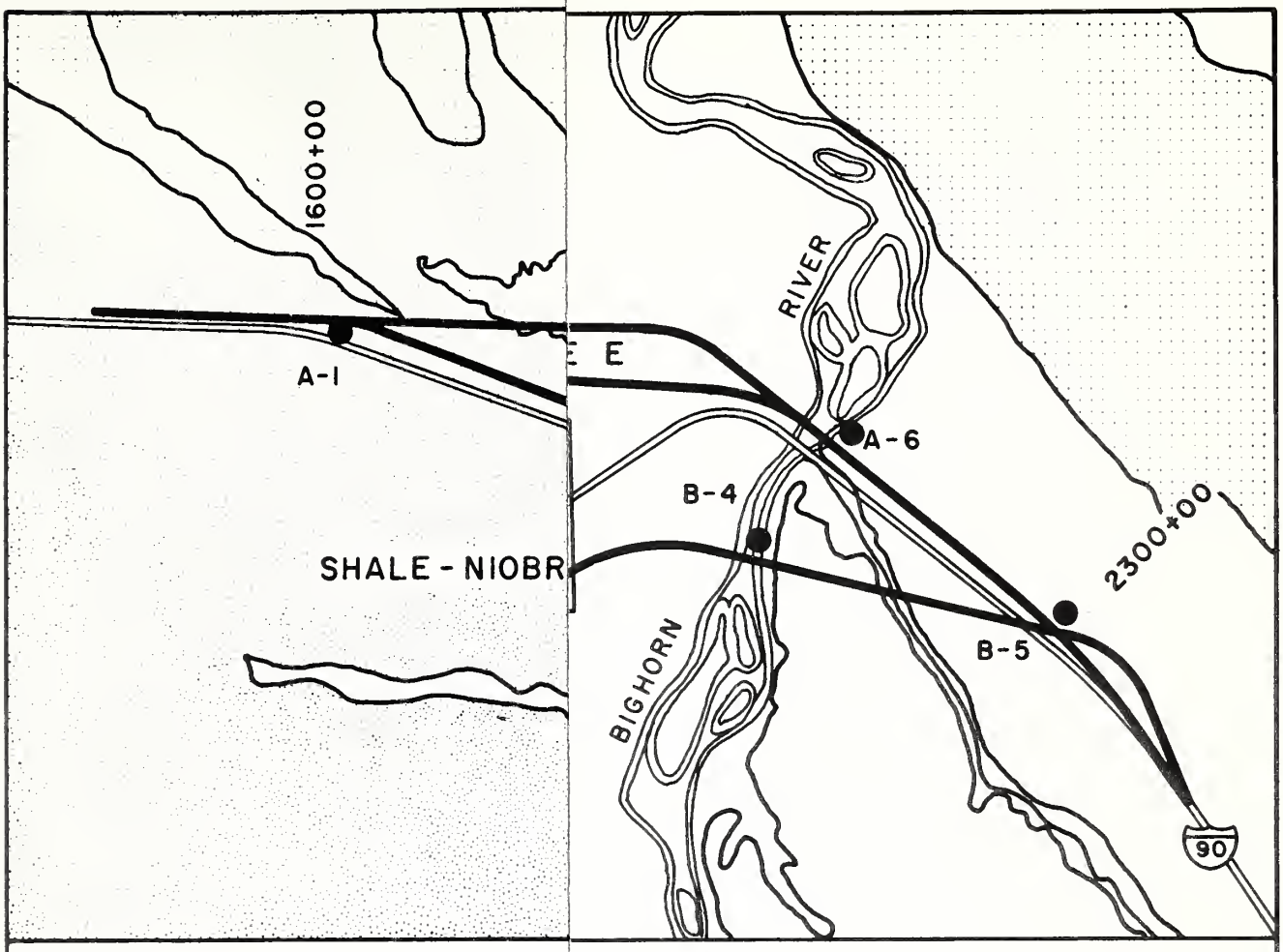
1. Aerial geology favors keeping the alignments north of the expansive Niobrara shale in the western portion of

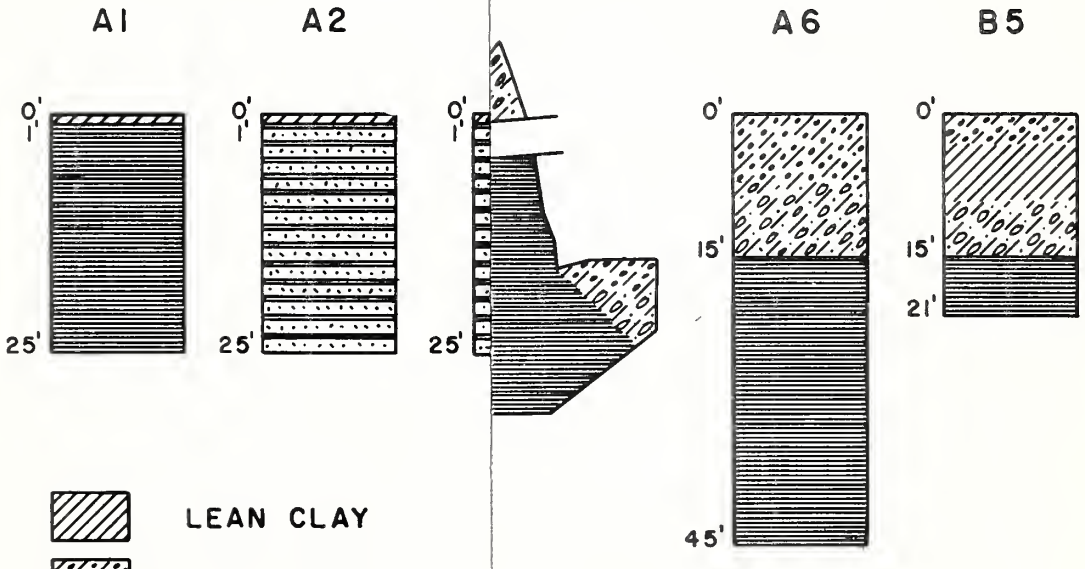
the study area. Geologically, Line A has a more desirable location for crossing the Big Horn River east of Hardin, due to the deep cut required through the bluff east of Hardin on the B Line, as well as the erosion problem caused by cutting of the bluff at the proposed bridge site at the Big Horn River on the B Line.

2. Thick subbases and special construction will be required in the west portion over the Niobrara shale, where encountered.

3. Location of adequate aggregate sources, within a reasonable distance for construction of the highway, may be difficult.

4. Piling of moderate length is indicated for river bridges while shallow spread footings appear practical for grade separations.





LEAN CLAY

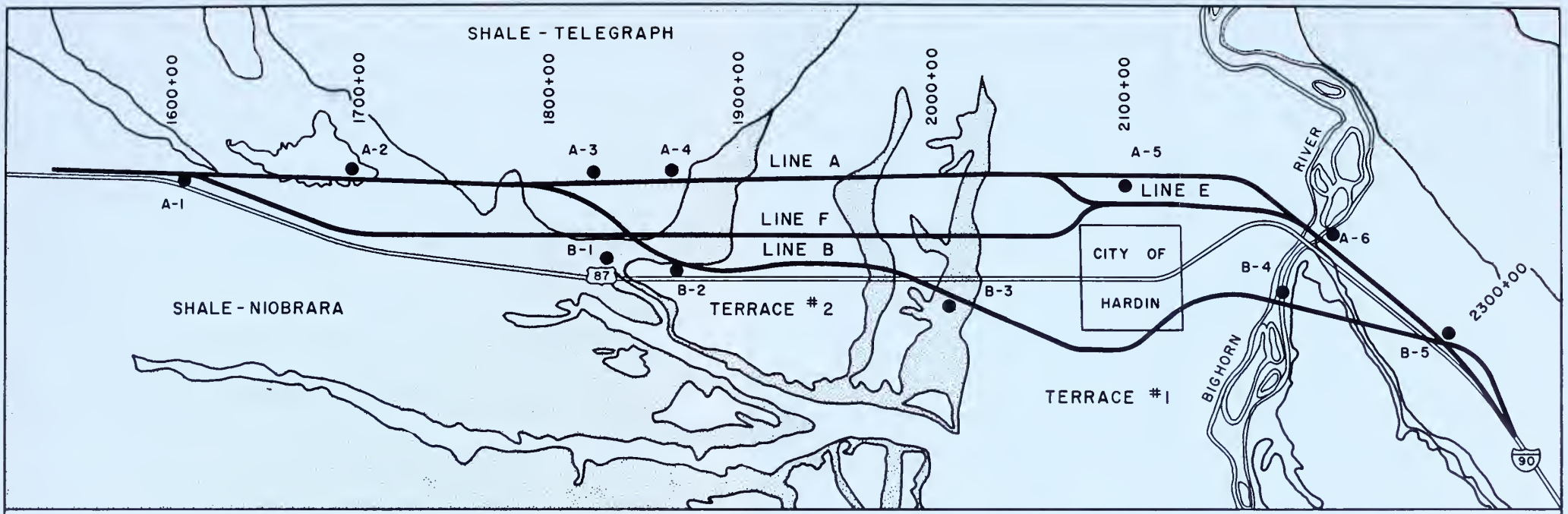
SILTY SAND

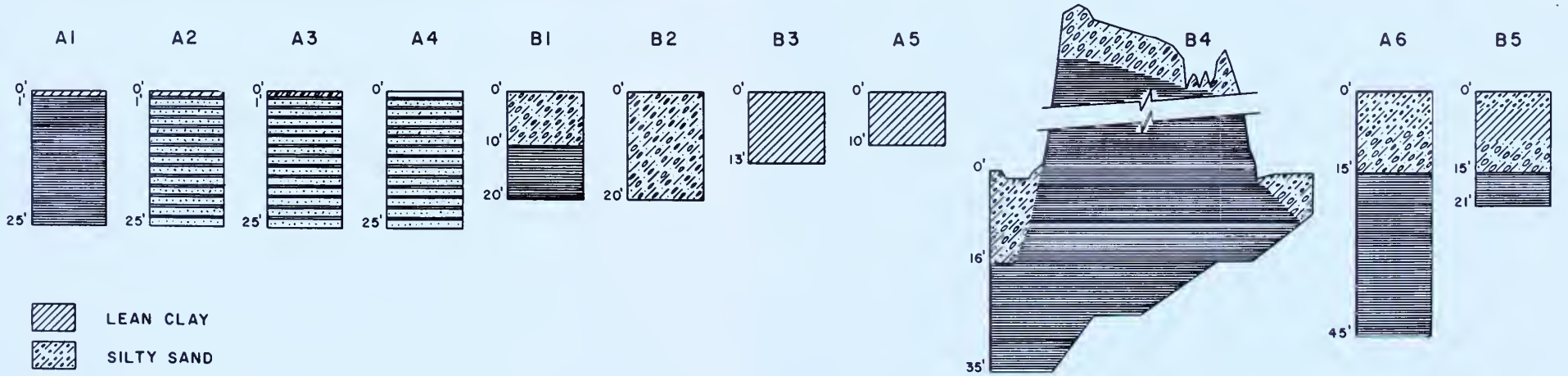
SILTY GRAVEL

SHALE - NIOBRARA

SHALE - TELEGRAPH

Figure S1





GEOLOGY MAP & SOIL PROFILE

PROJECT I-90-9(8)471

Figure S1

TABLE S-I

SOIL CLASSIFICATION DATA

Station	Depth	Liquid Limit	Plast. Index	Pass #200	Group Index	Class	*Feature
A, B&E 1540	2'	59	30	90	20	A-7-6	Kcnc
A&E 1660 (2000' south)	8'	46	26	85	15	A-7-6	Kcnc
A&E 1710 (3300' south)	4'	55	43	87	19	A-7-6	Kcnc
A&E 1720 (3300' south)	3'	180	148	95	20+	A-7-6	Bentonite
A 1840	15'	45	25	99	15	A-7-6	Kct
B 1970	2'	36.5	19.5	93	12	A-6	Qt_2
A 2102	2'	30	9	30	0	A-2-4	Qt_1

* Note:

Kcnc	Niobrara Shale
Kct	Telegraph Shale
Qt_1	First River Terrace
Qt_2	Second River Terrace

INDEX OF SHEETS

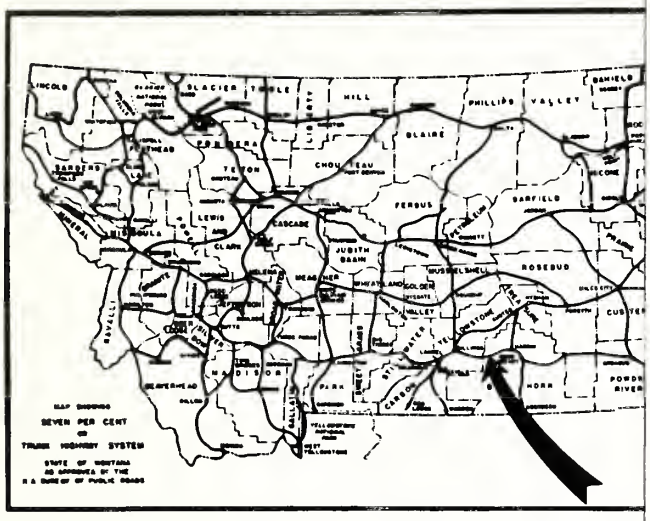
1 TITLE SHEET
2-3 TYPICAL SECTIONS
5-16 PLAN & PROFILE
17 BRIDGE LAYOUT CRITERIA

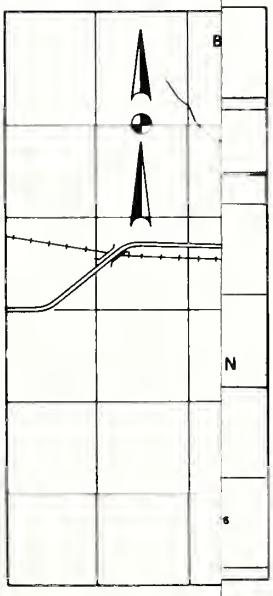
FED. ROAD DIV. NO.	STATE		FISCAL YEAR	SHEET NO	TOTAL SHEETS
	MONT.			1	17

STATE NUMBER _____

PLANS COMPLETED _____

CONTRACT COMPLETED _____





THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

INDEX OF SHEETS

1 TITLE SHEET
2-3 TYPICAL SECTIONS
5-16 PLAN & PROFILE
17 BRIDGE LAYOUT CRITERIA

STATE OF MONTANA

STATE HIGHWAY COMMISSION

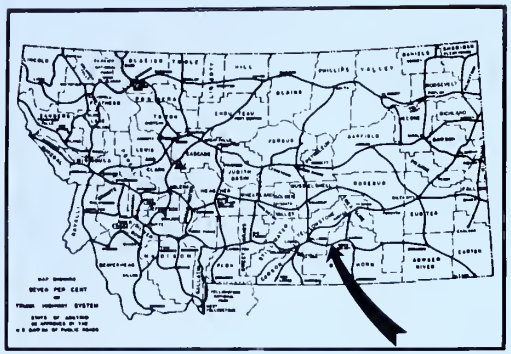
FED. ROAD DIV. NO.	STATE		FISCAL YEAR	SHEET NO.	TOTAL SHEETS
	MONT			1	17

STATE NUMBER _____

PLANS COMPLETED _____

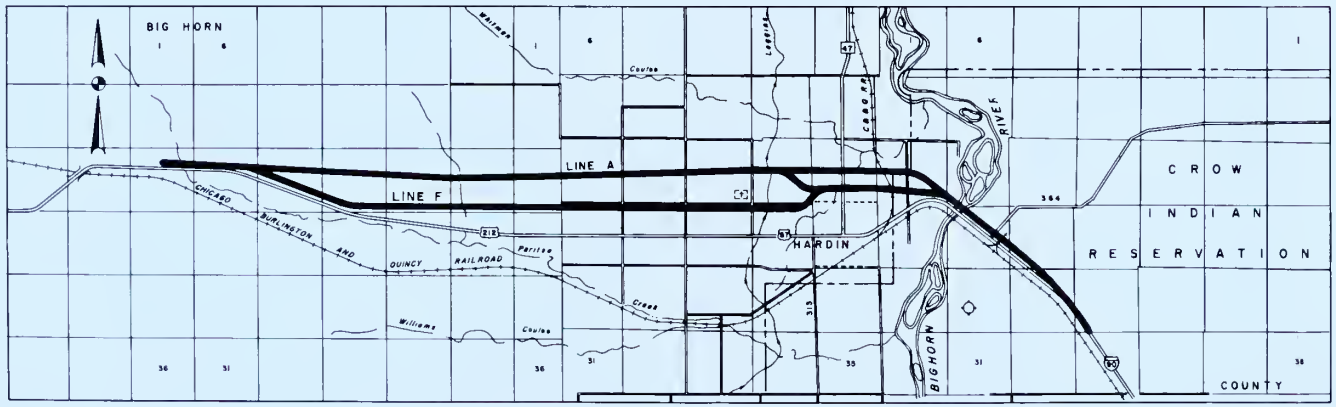
CONTRACT COMPLETED _____

PLAN AND PROFILE OF PROPOSED
INTERSTATE 90 ROUTING
TOLUCA TO HARDIN



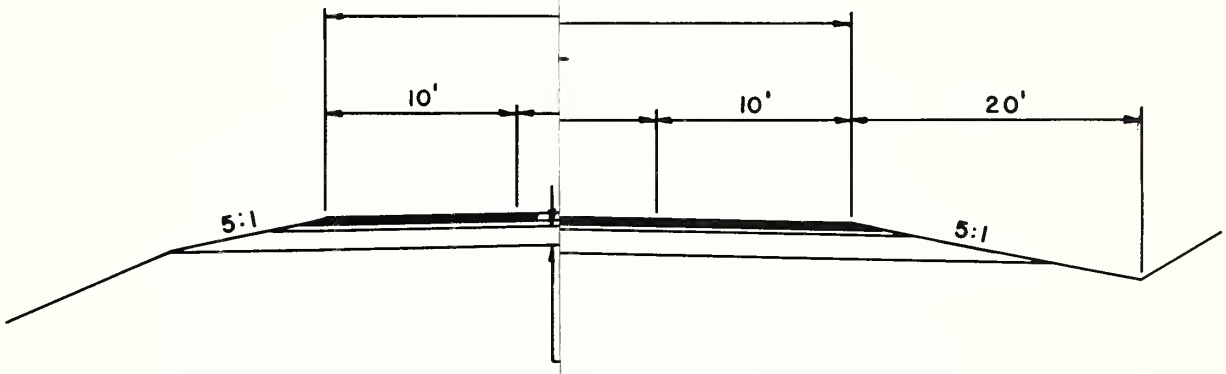
SCALES

HORIZONTAL: 1 Inch = 1000 Feet
VERTICAL: 1 Inch = 50 Feet



THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

SHEET NO.	TOTAL SHEETS
2	17



‡ F LINE STA. 1530+00 TO 1850+00
‡ A, B & E LINES STA. 1530+00 TO 1640+00

* A LINE STA. 1640+00 TO 2336+00
* B LINE STA. 1640+00 TO 2344+00
* E LINE STA. 1640+00 TO 2336+00
* F LINE STA. 1850+00 TO 2336+00

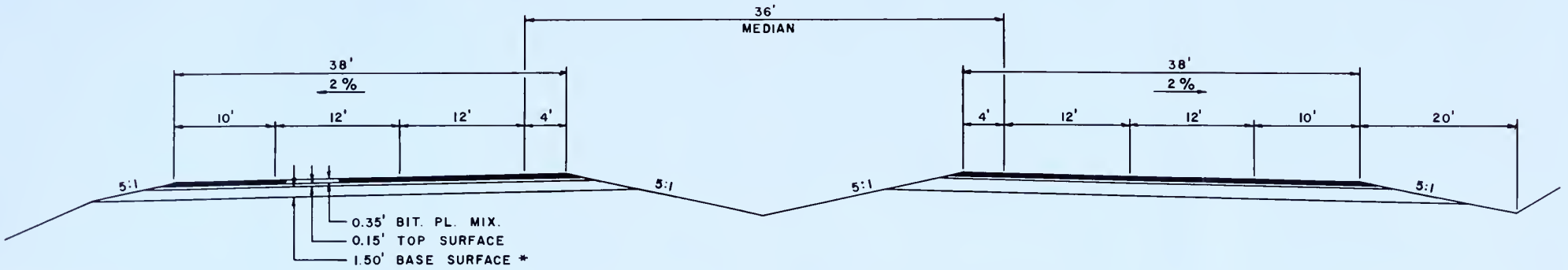
• FOR ESTIMATING PURPOSES ONLY

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

TYPICAL

ROADWAY SECTIONS

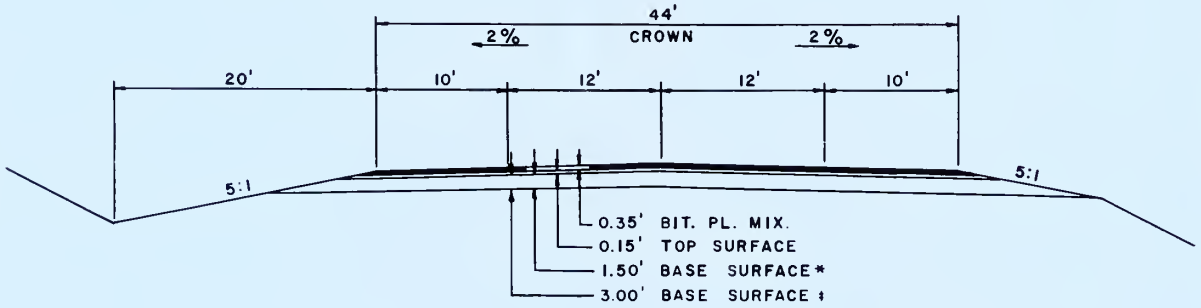
THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO



FOUR LANE•
INTERSTATE

‡ F LINE STA. 1530+00 TO 1850+00
‡ A, B & E LINES STA. 1530+00 TO 1640+00

* A LINE STA. 1640+00 TO 2336+00
* B LINE STA. 1640+00 TO 2344+00
* E LINE STA. 1640+00 TO 2336+00
* F LINE STA. 1850+00 TO 2336+00



TWO LANE•
INTERSTATE

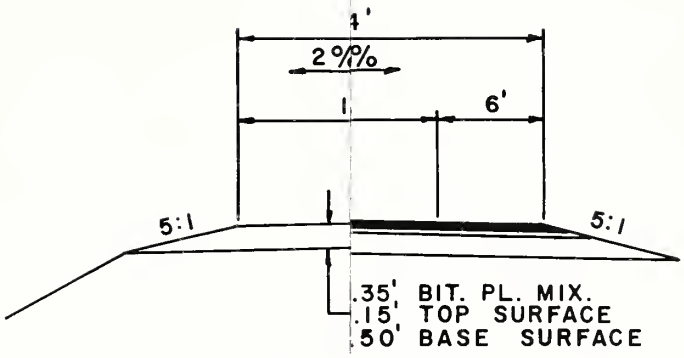
• FOR ESTIMATING PURPOSES ONLY

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

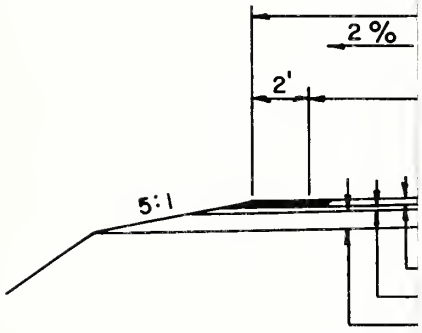
TYPICAL
ROADWAY SECTIONS

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

SHEET NO.	TOTAL SHEETS
3	17



FROE RAMPS



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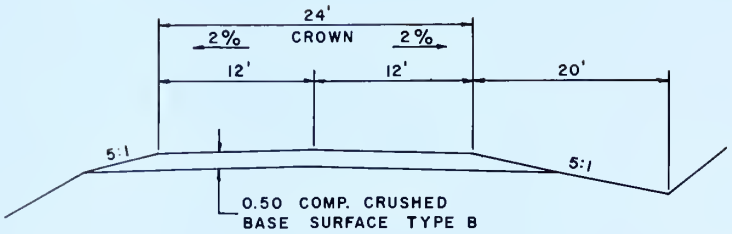
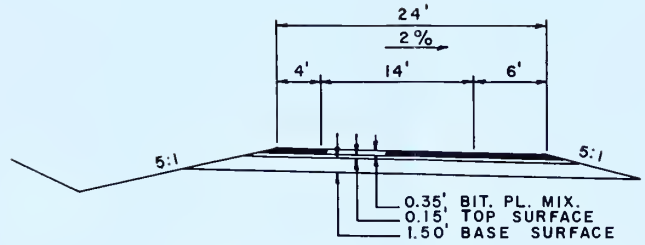
STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

TYPICAL
ROADWAY SECTIONS

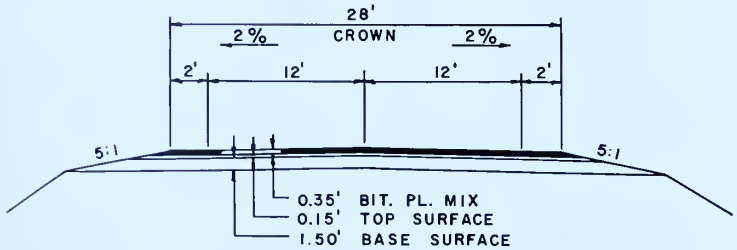
THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO



FRONTAGE ROADS



INTERSTATE RAMPS



MONTANA 47 - U.S. 87

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

TYPICAL

ROADWAY SECTIONS

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO

SHEET NO.	TOTAL SHEETS
4	17

LEGEND

EXISTING FEATURES

PAVED ROAD

TRAIL

BRIDGE

STREAM

INTERMITTENT STREAM

IRRIGATION DITCH

DEPRESSION

RAILROAD

SPOT ELEVATION X 3132

BUILDINGS

UTILITY POLE

RESERVOIR & DAM

NATURAL GAS WELLS

PROPOSED FEATURES

INTERSTATE HIGHWAY

INTERCHANGE

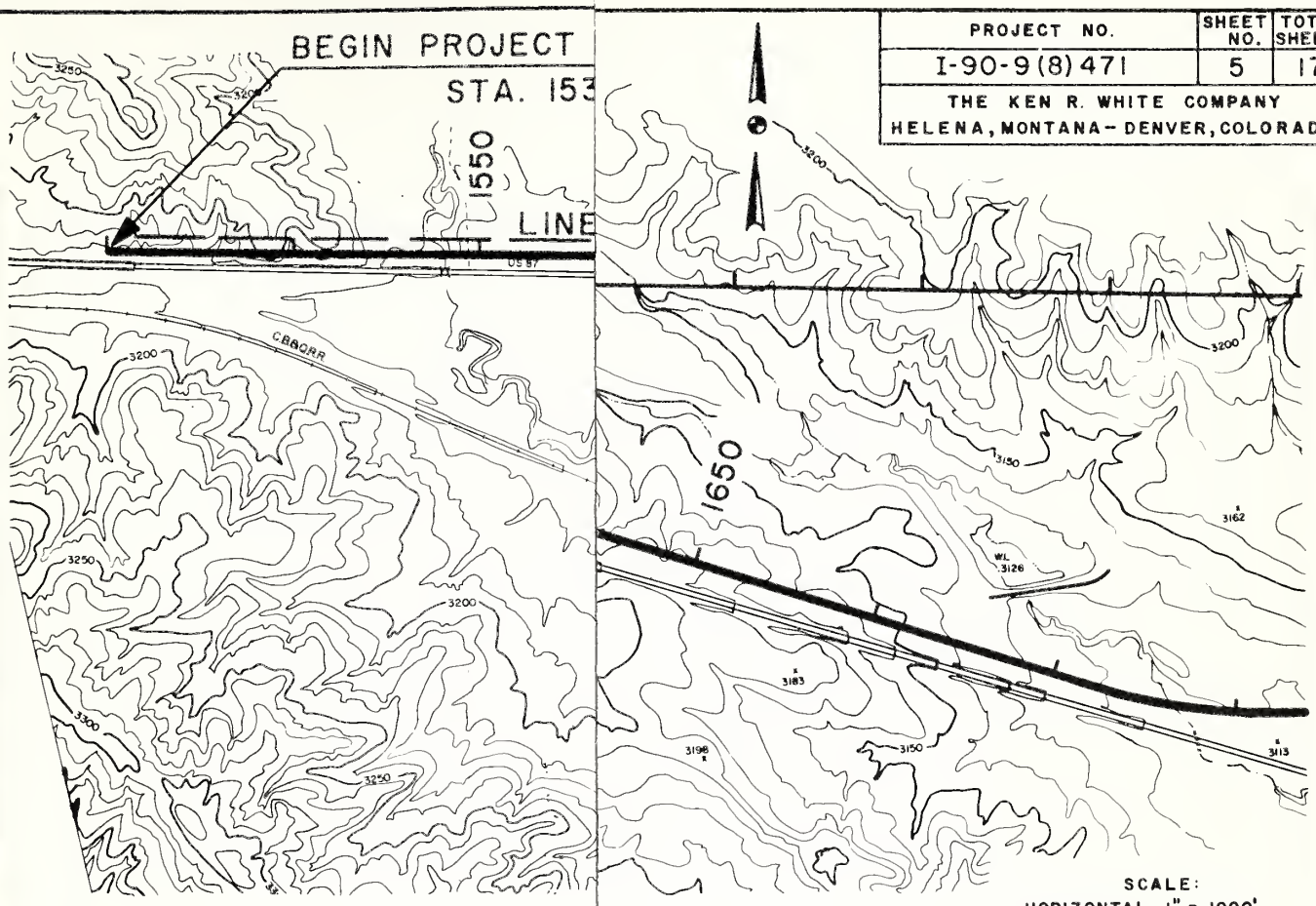
GRADE SEPARATION

FRONTAGE ROAD

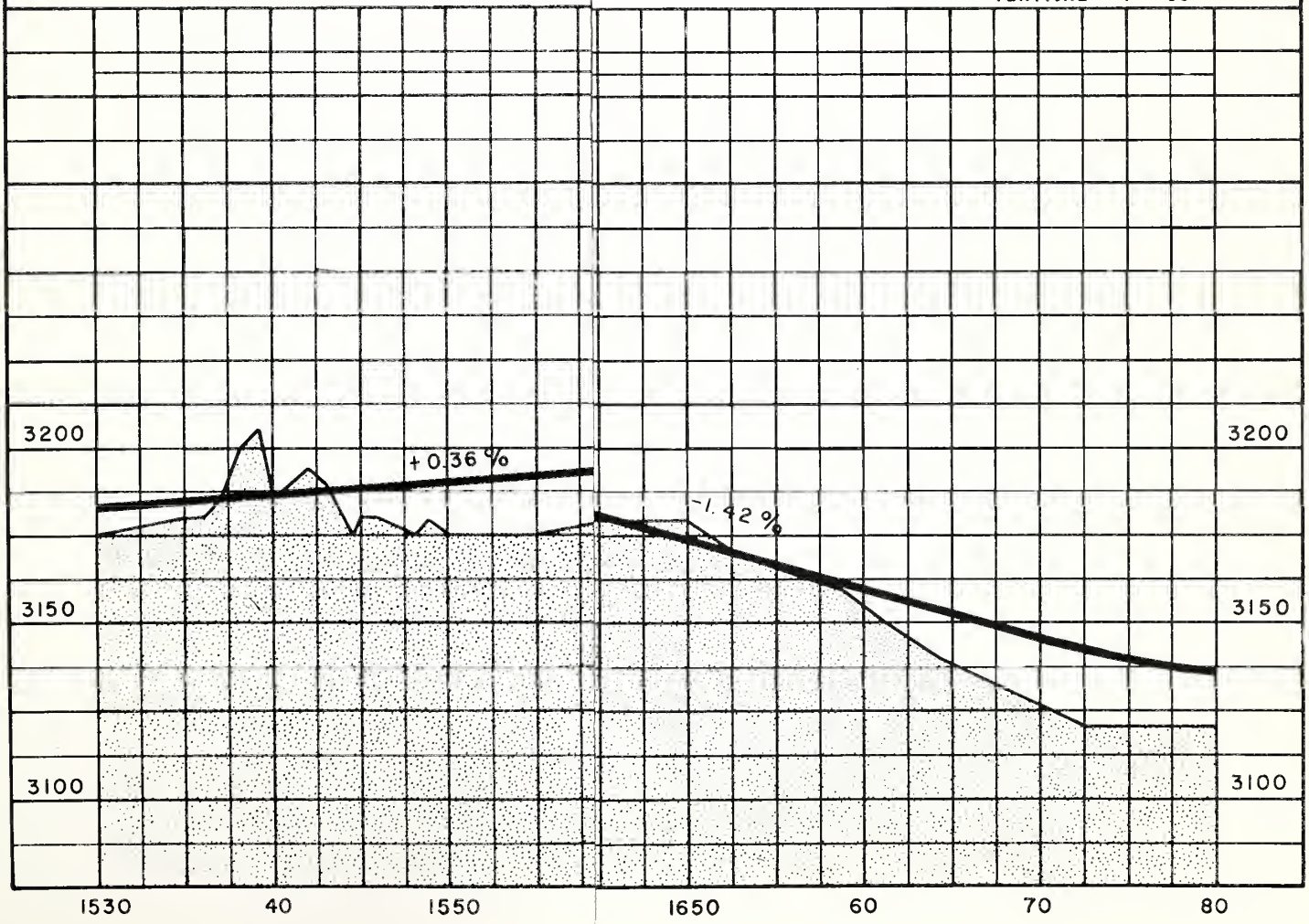
EXISTING ROAD REALIGNMENT

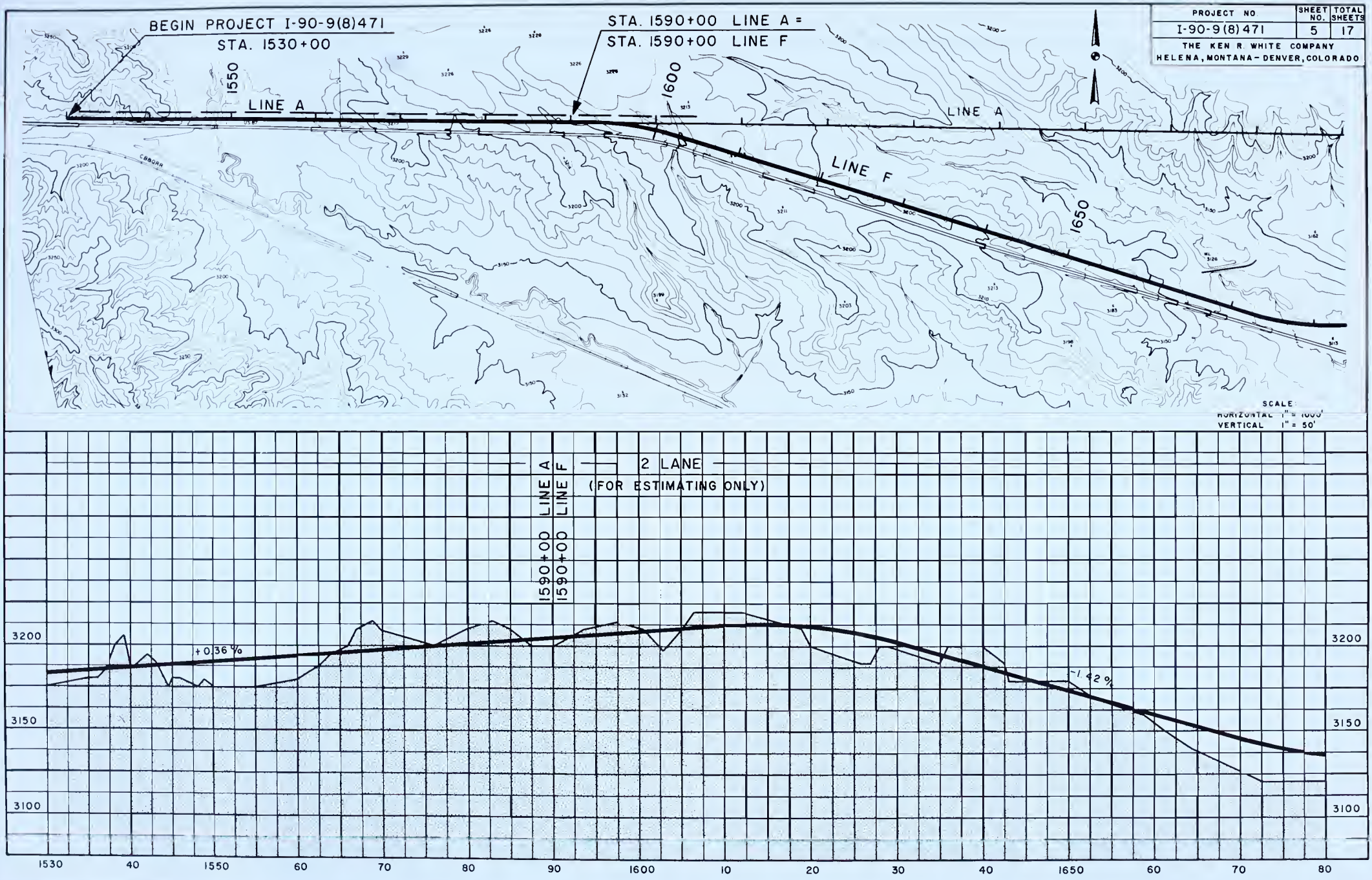
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	5	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

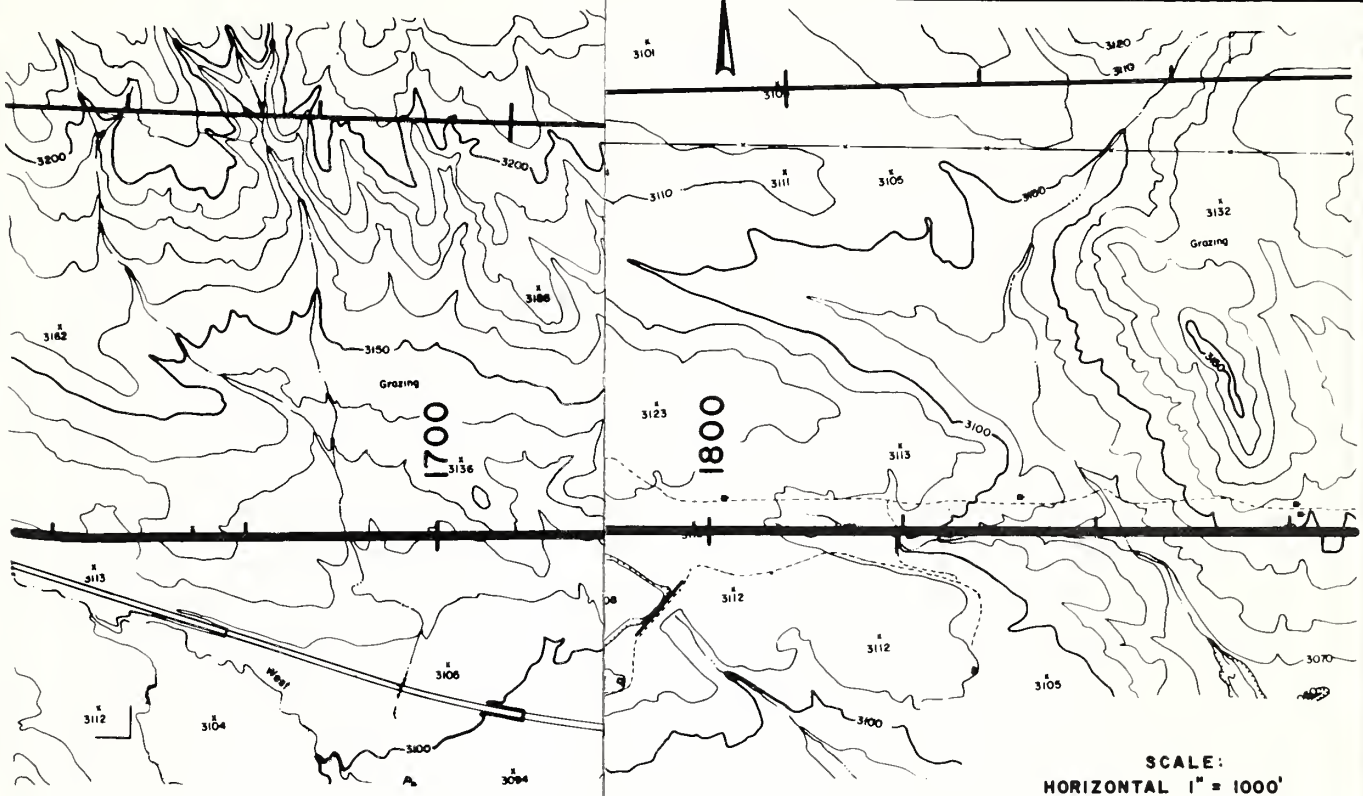


SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'

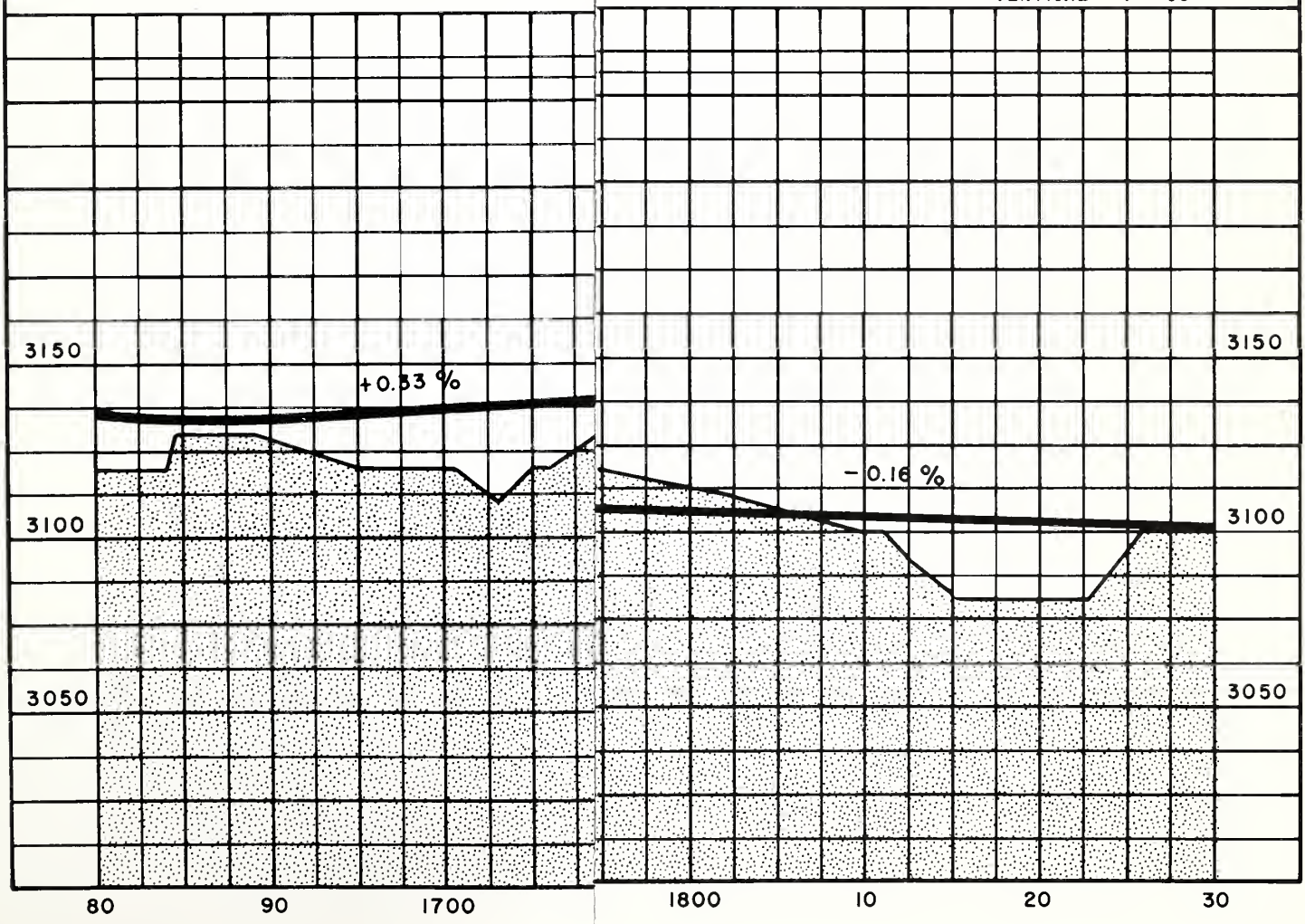



BEGIN PROJECT I-90-9(8)471
STA. 1530+00
STA. 1590+00 LINE A =
STA. 1590+00 LINE F
1550
1600
1650
LINE A
LINE A
LINE F
CBBGAR
PROJECT NO
I-90-9(8)471
SHEET NO. 5
TOTAL SHEETS 17
THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO
SCALE
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'
2 LANE
(FOR ESTIMATING ONLY)
1590+00 LINE A
1590+00 LINE F
+0.36 %
-1.42 %
3200
3150
3100
1530
40
1550
60
70
80
90
1600
10
20
30
40
1650
60
70
80

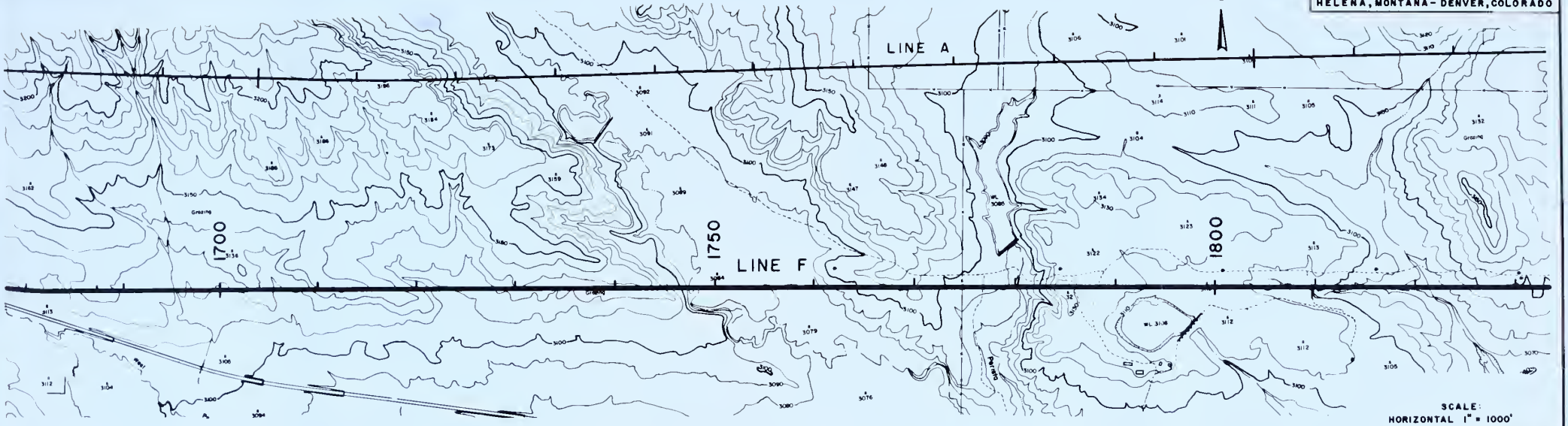
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	6	17
THE KEN R. WHITE COMPANY HELENA, MONTANA - DENVER, COLORADO		



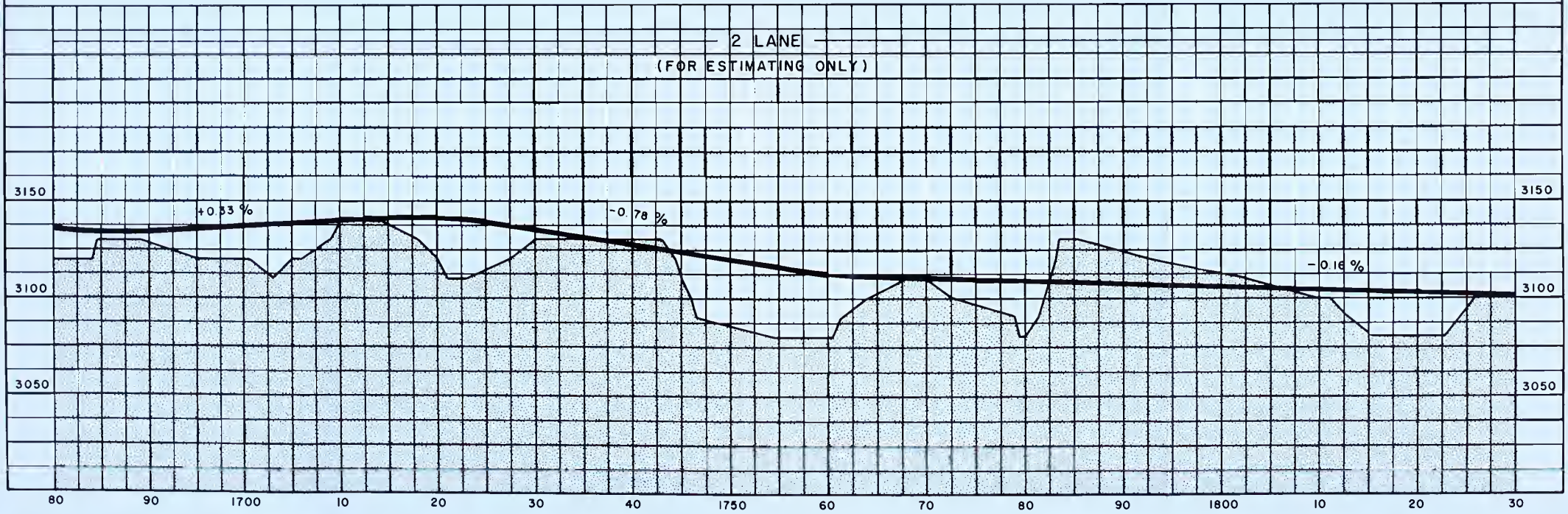
SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'



PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	6	17
THE KEN R. WHITE COMPANY HELENA, MONTANA - DENVER, COLORADO		

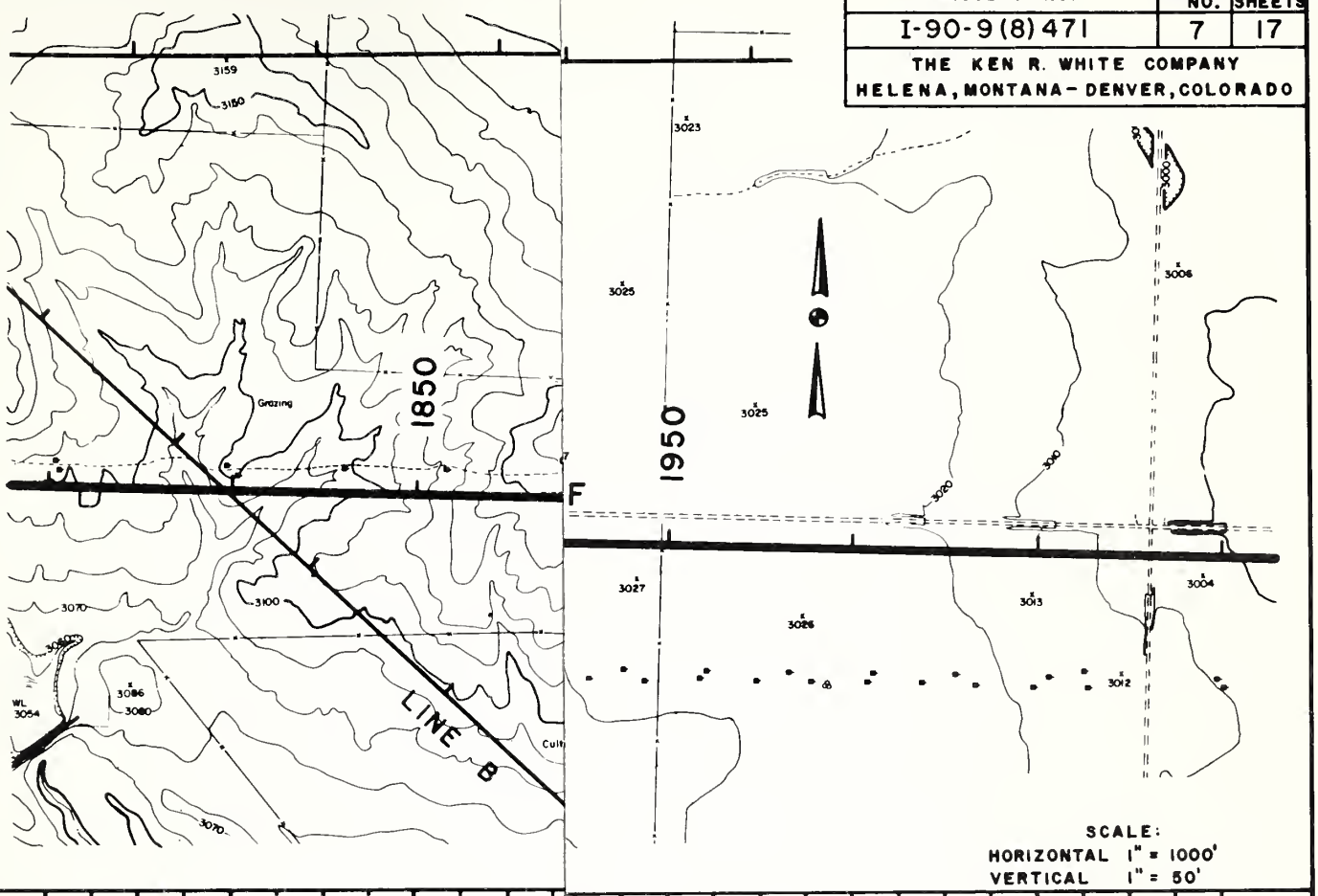


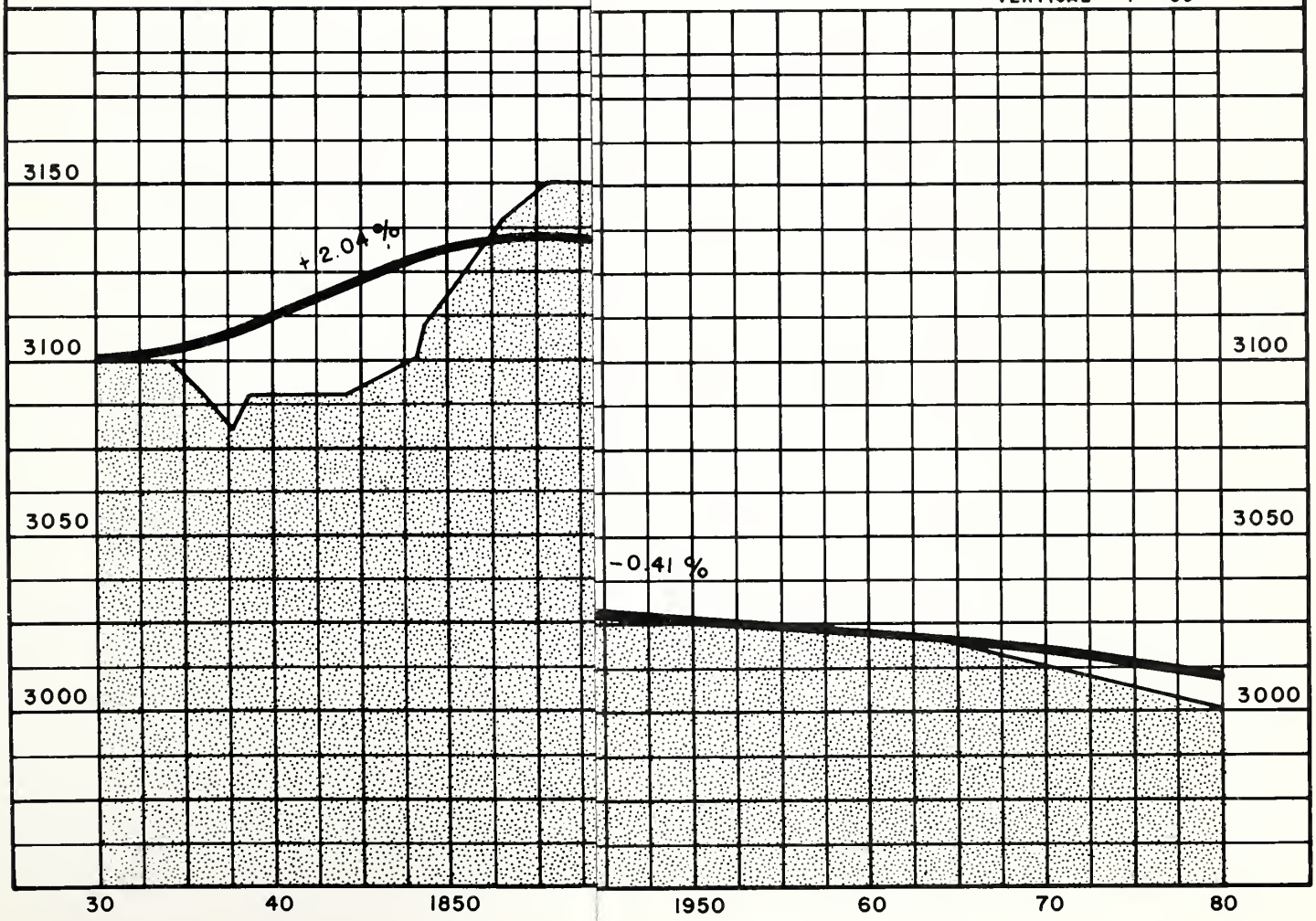
SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'



PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	7	17

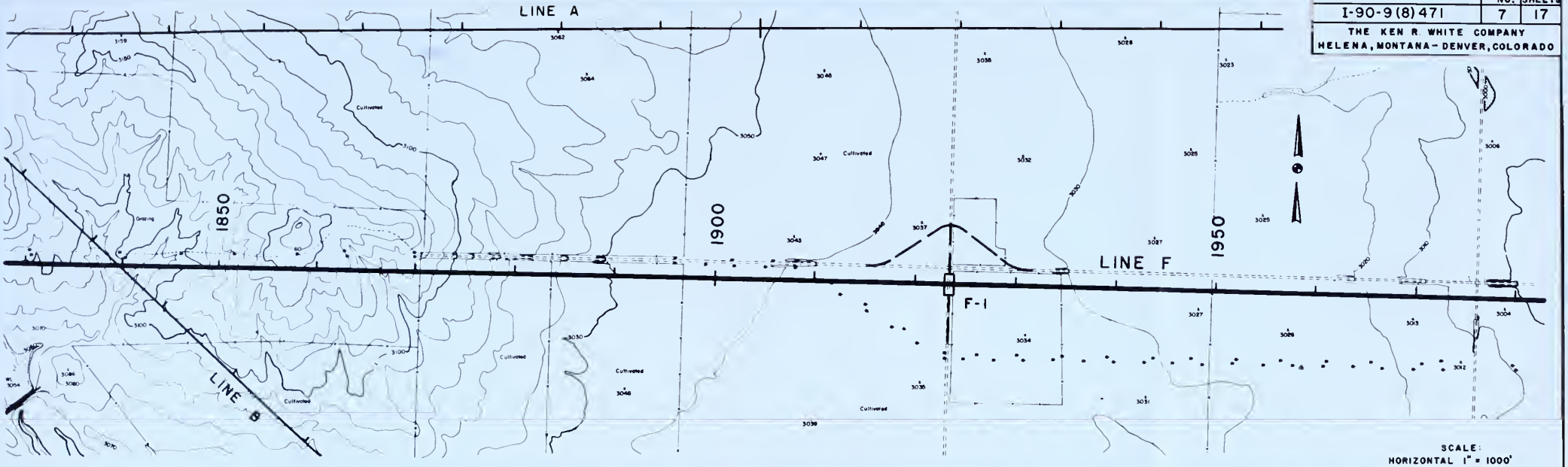
THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO





PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	7	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO



SCALE:
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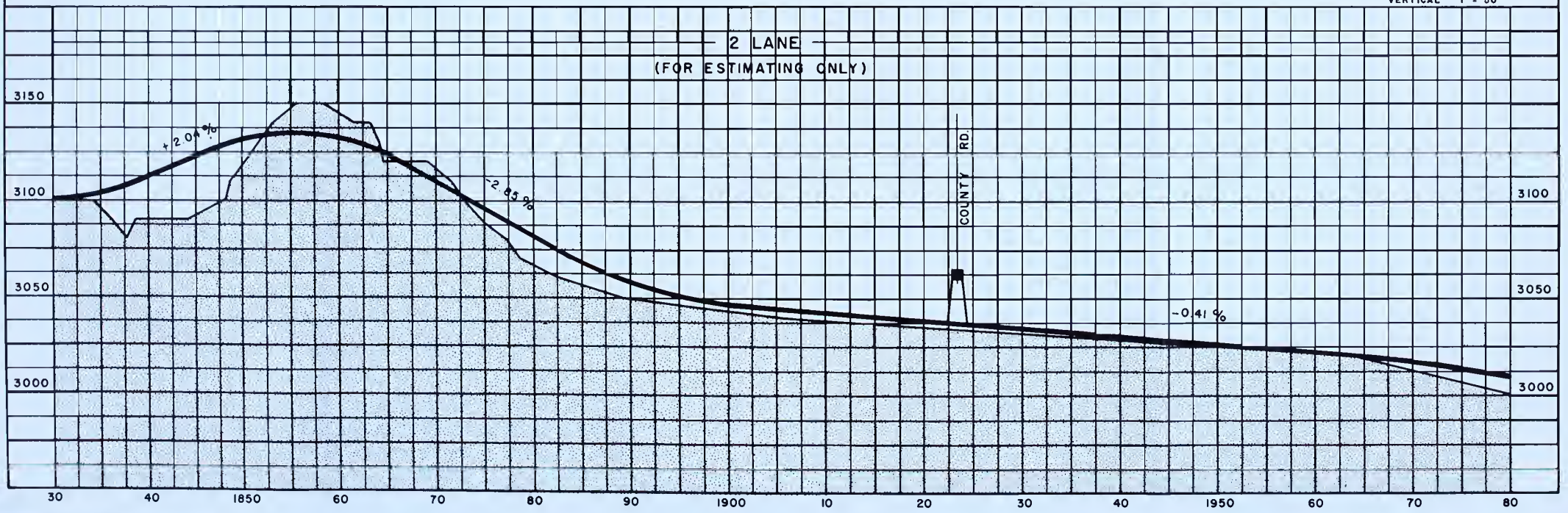
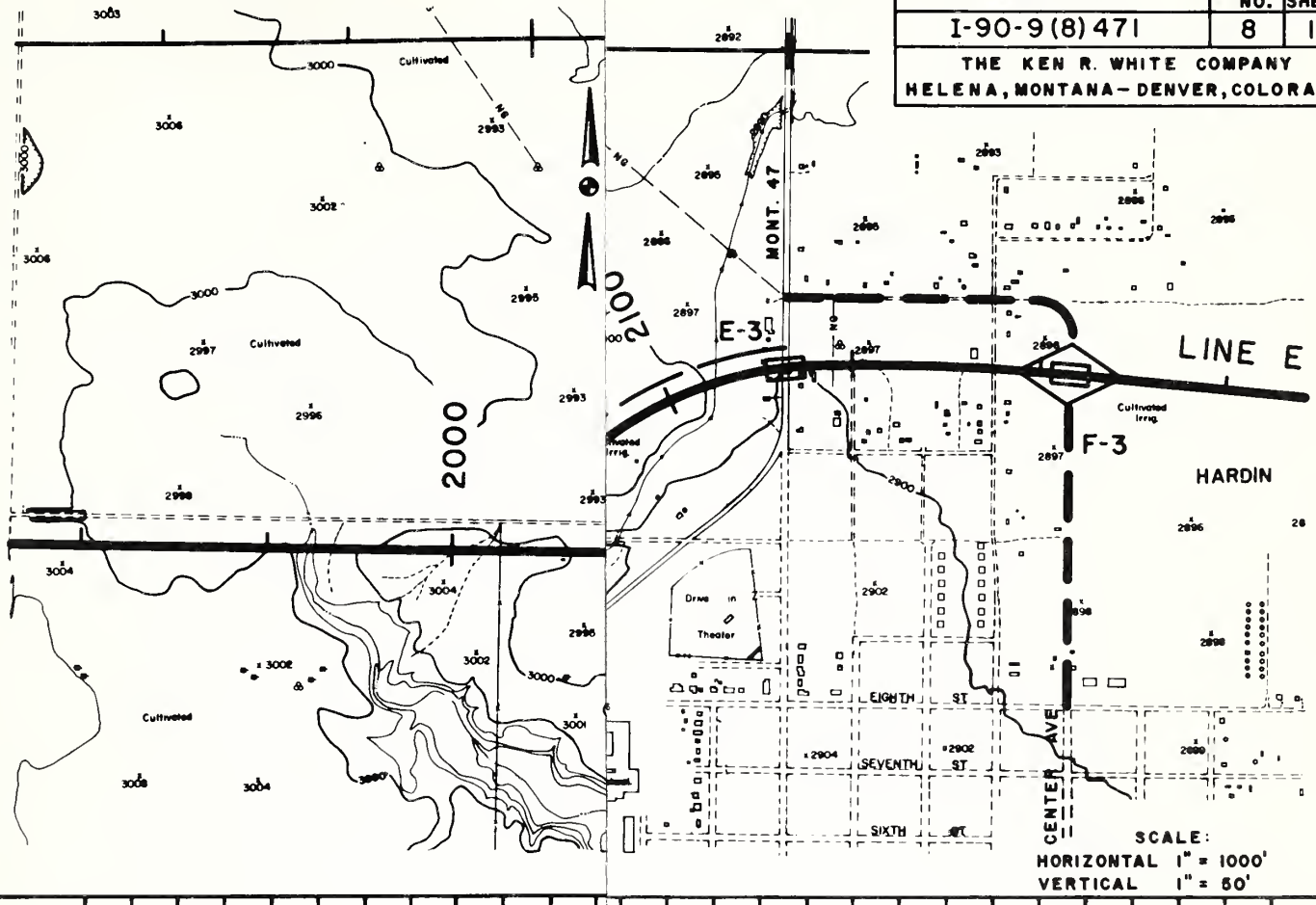
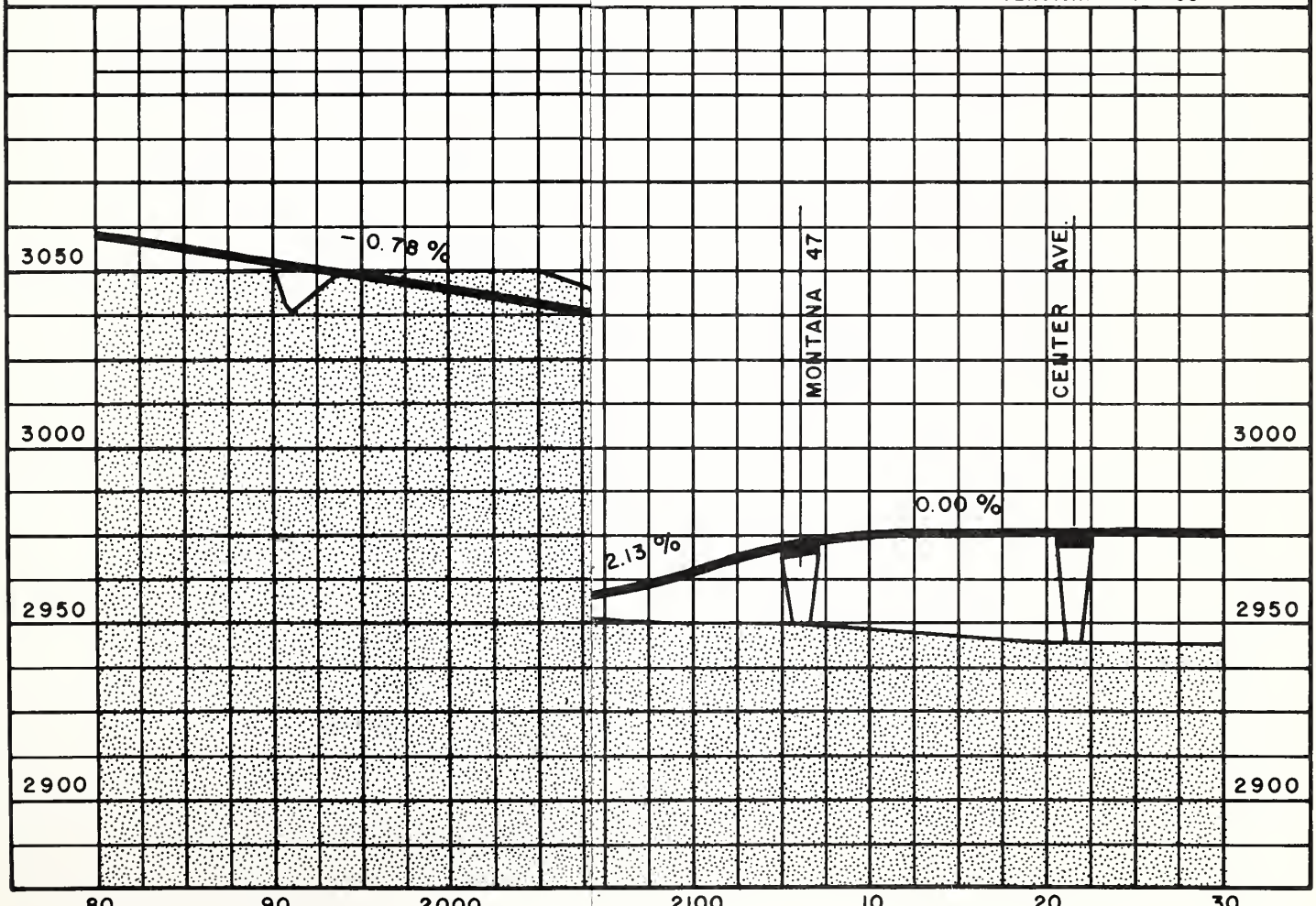
VERTICAL 1" = 50'



PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	8	17

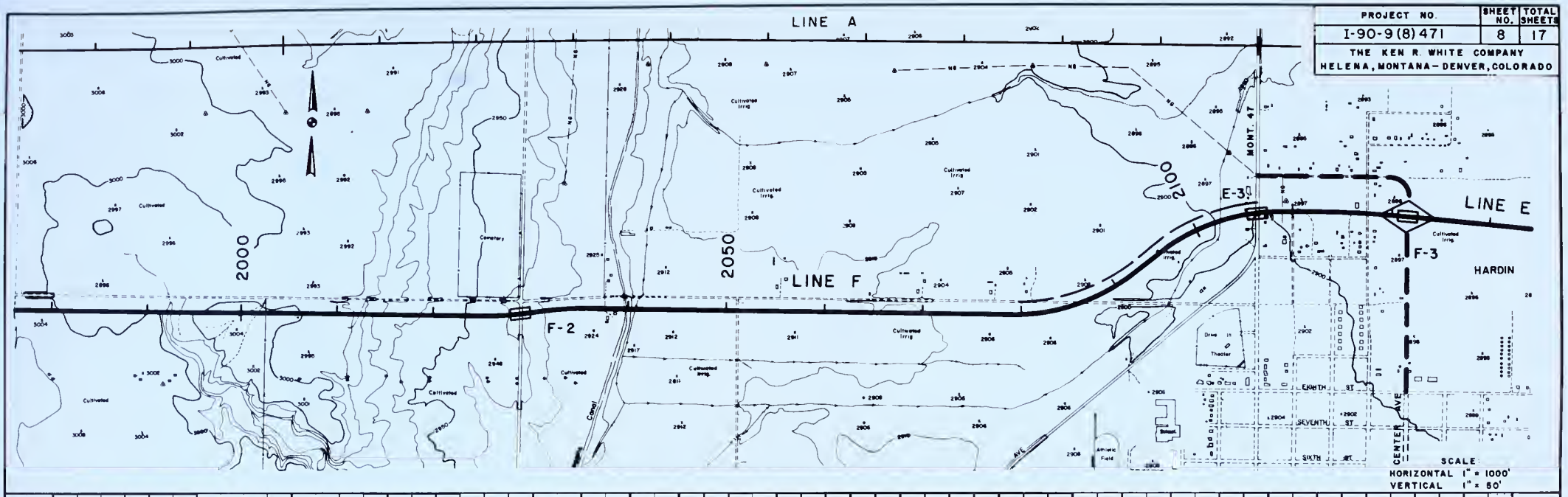
THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

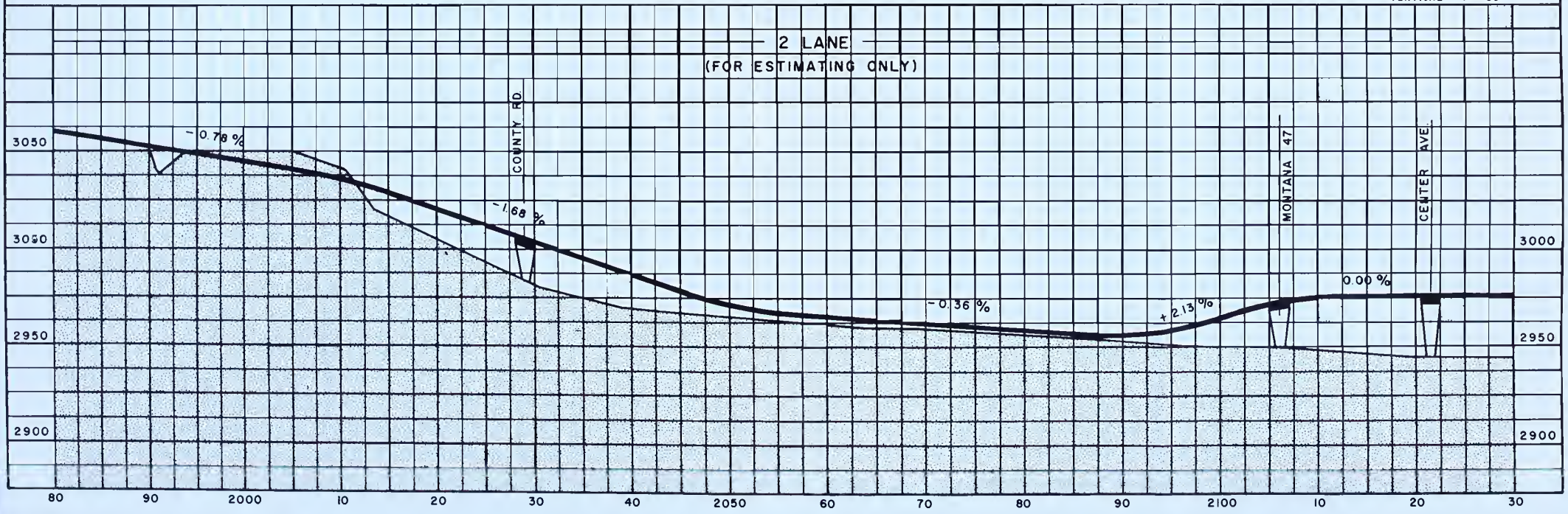




PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	8	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO





PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	9	17
THE KEN R. WHITE COMPANY HELENA, MONTANA – DENVER, COLORADO		

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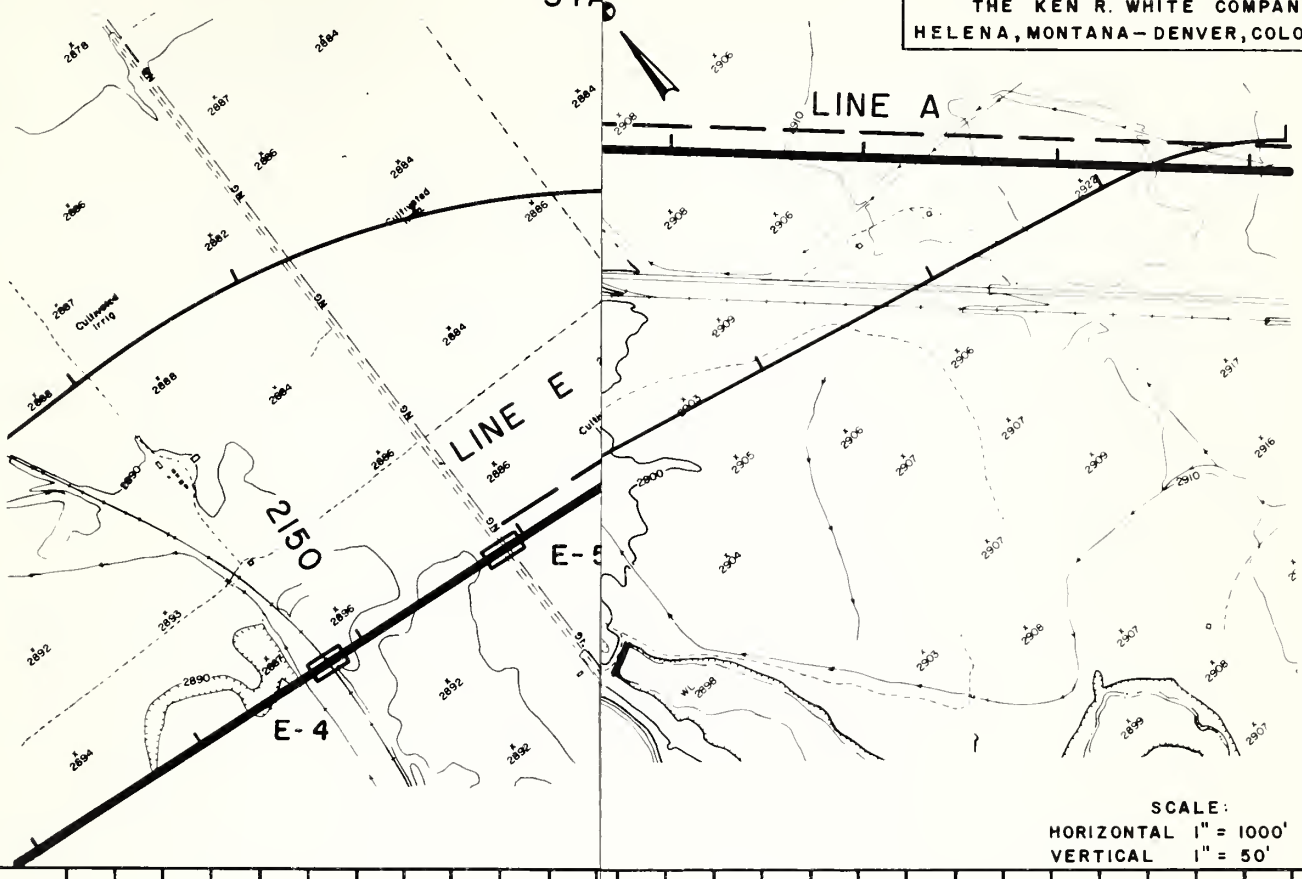
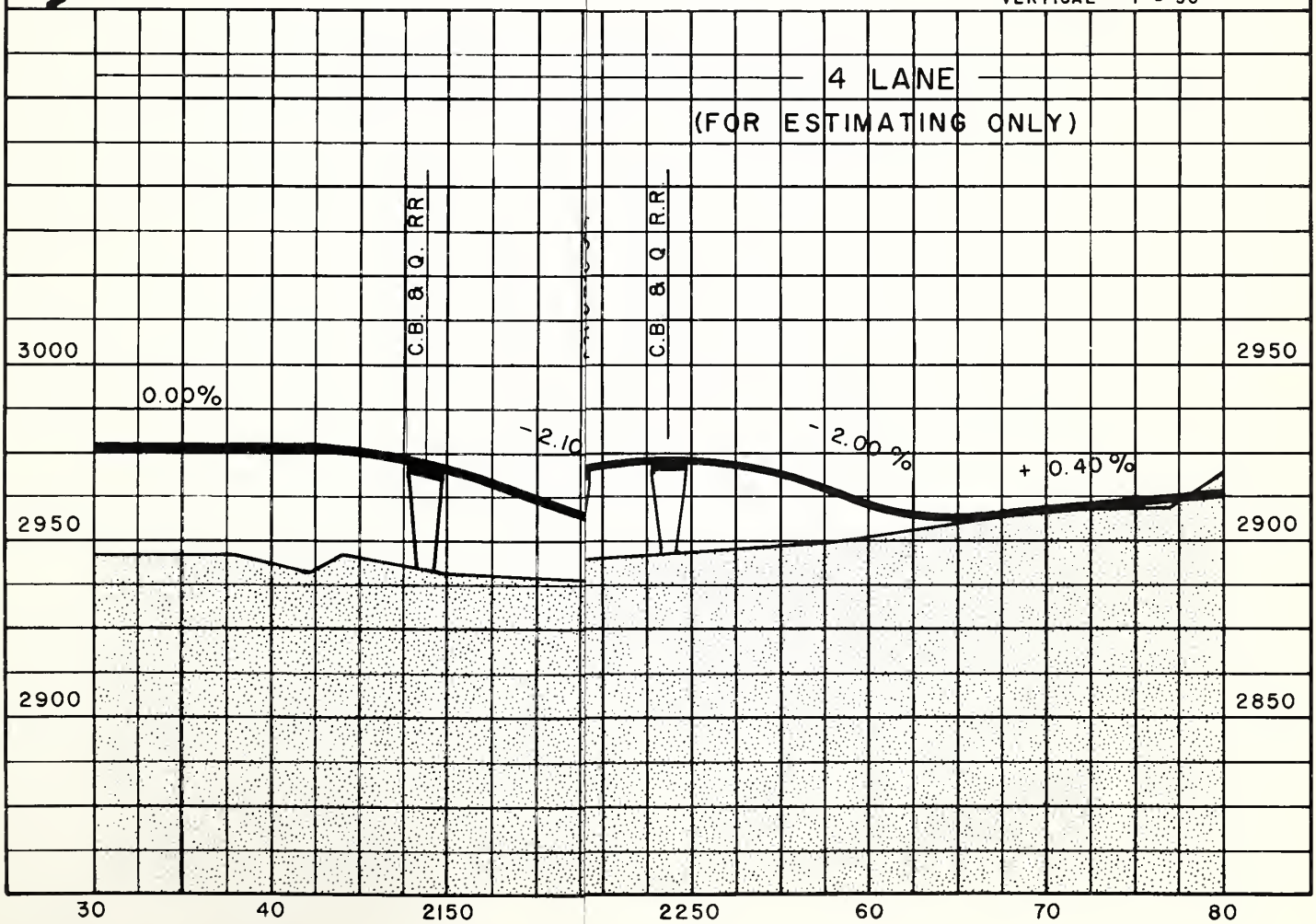
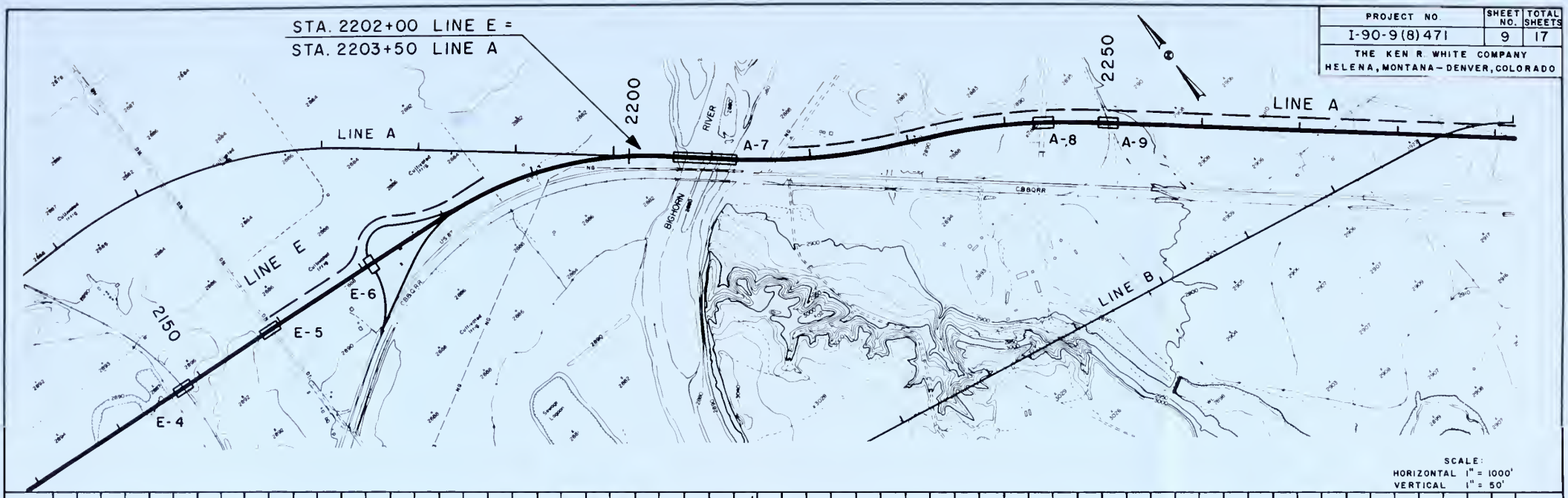
STA

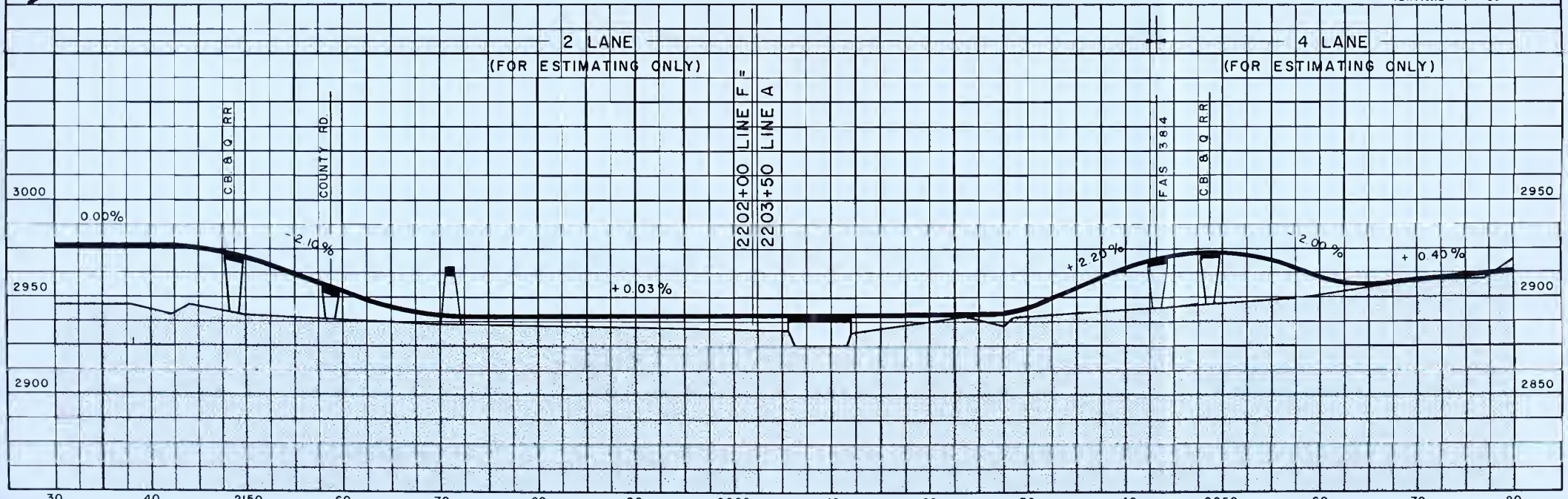


SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'



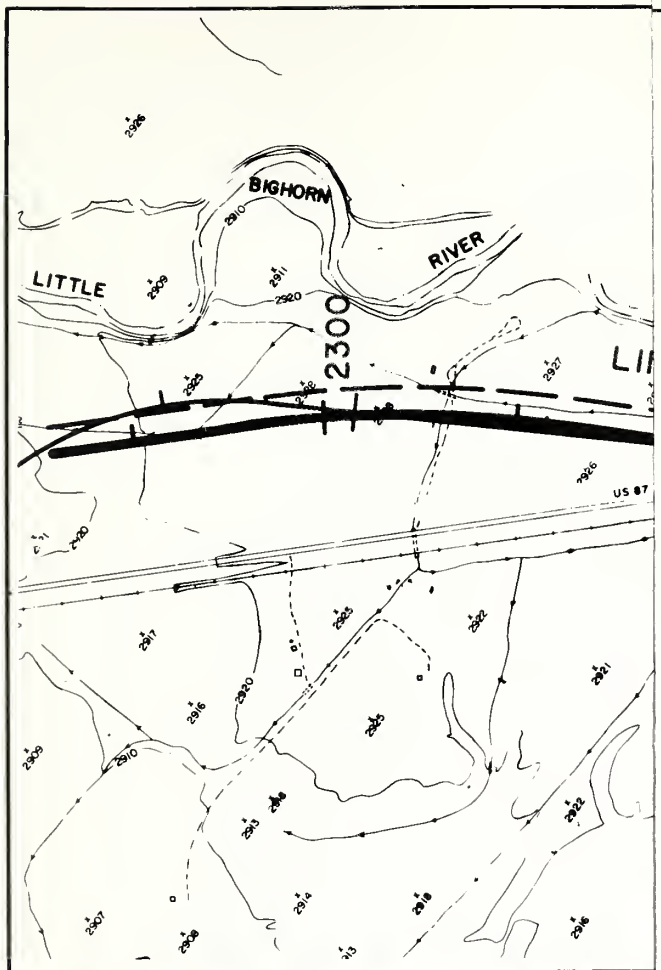
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	9	17
THE KEN R. WHITE COMPANY HELENA, MONTANA – DENVER, COLORADO		





PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	10	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO



SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'

4 LAN
(FOR ESTIMATI

3000
2950
2900
2850

+0.40%

80 90 2300

PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	10	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO

SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50

4 LANE
(FOR ESTIMATING ONLY)

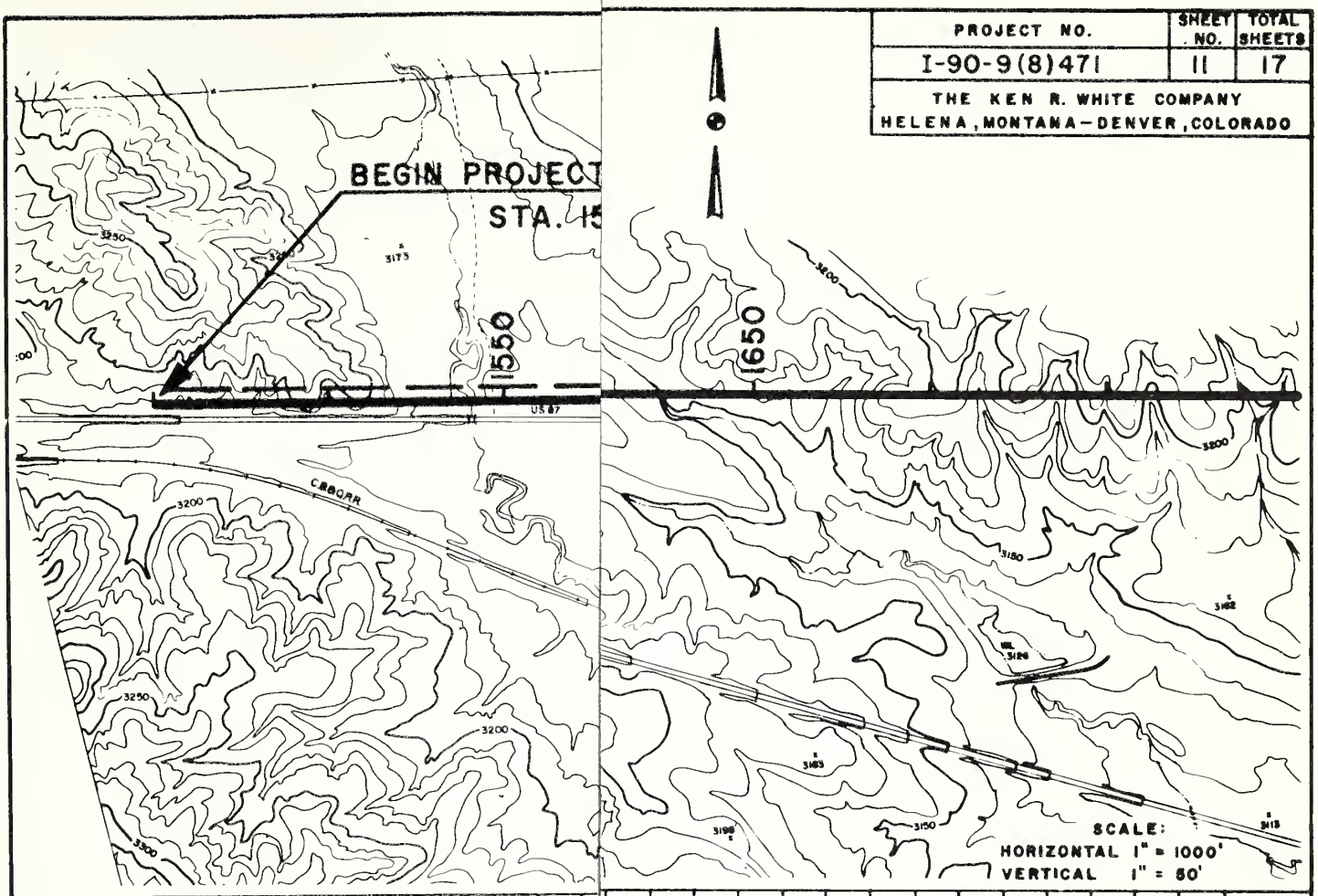
3000
2950
2900
2850

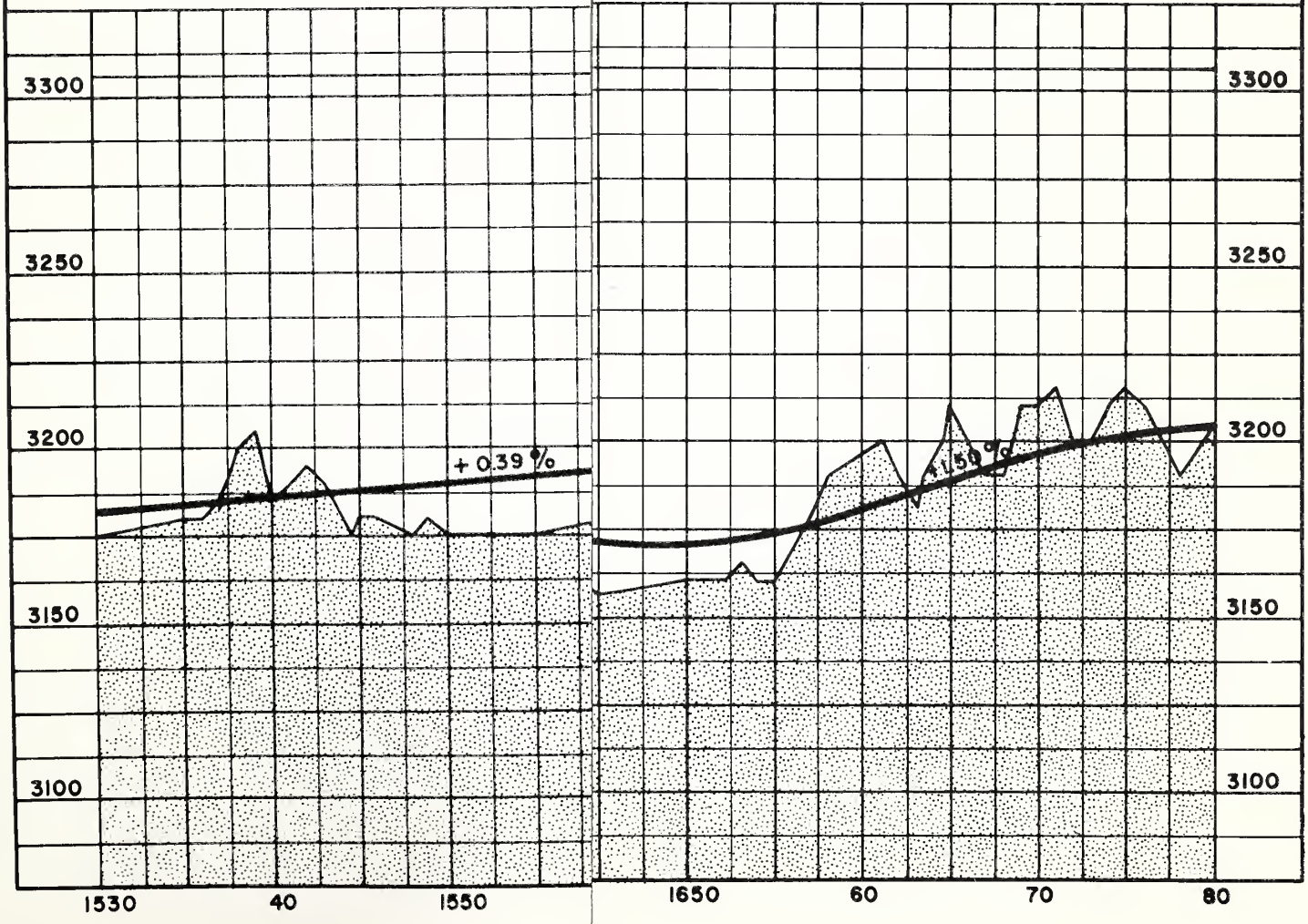
+0.40%
0.00%

80 90 2300 10 20 30

PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	11	17

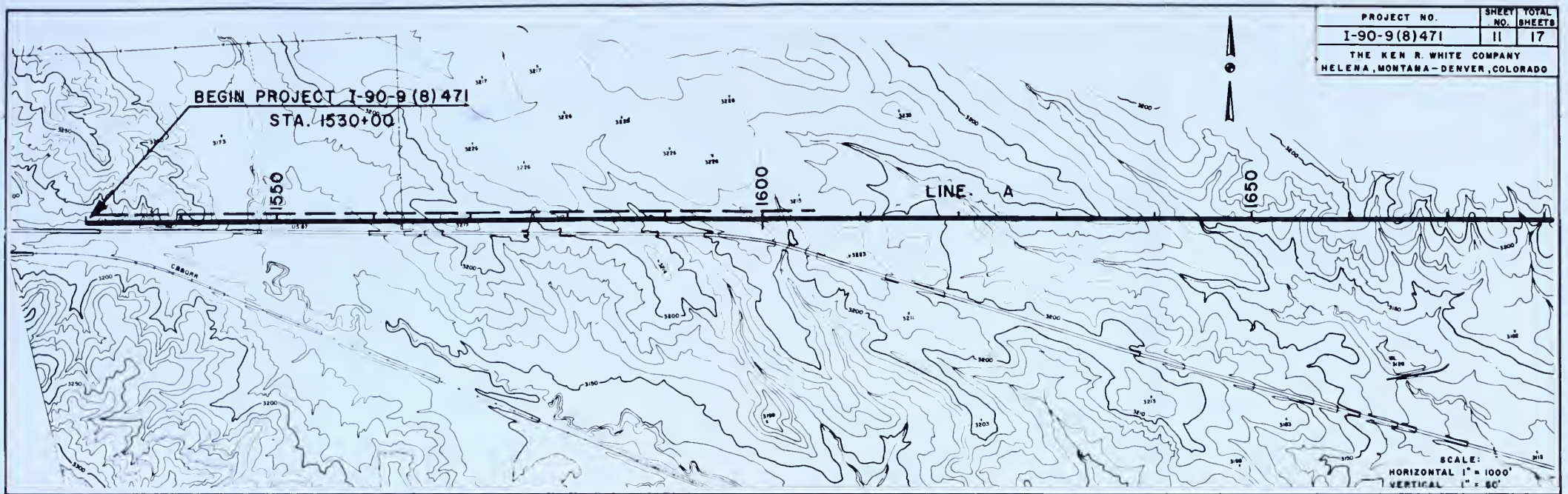
THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

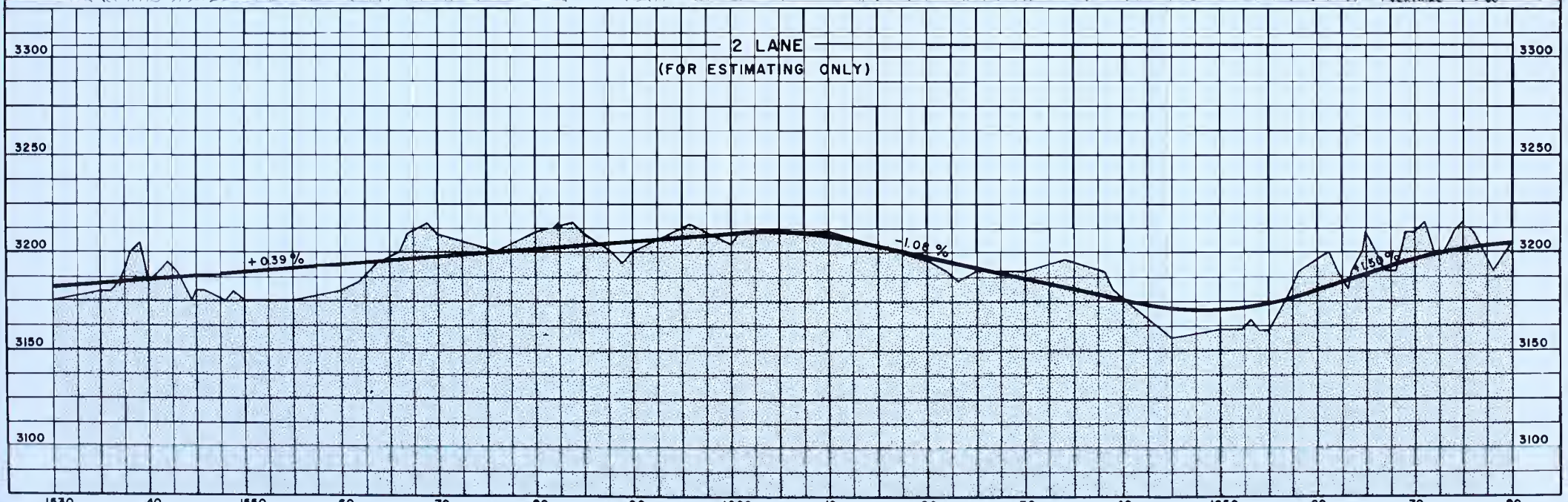




PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	11	17

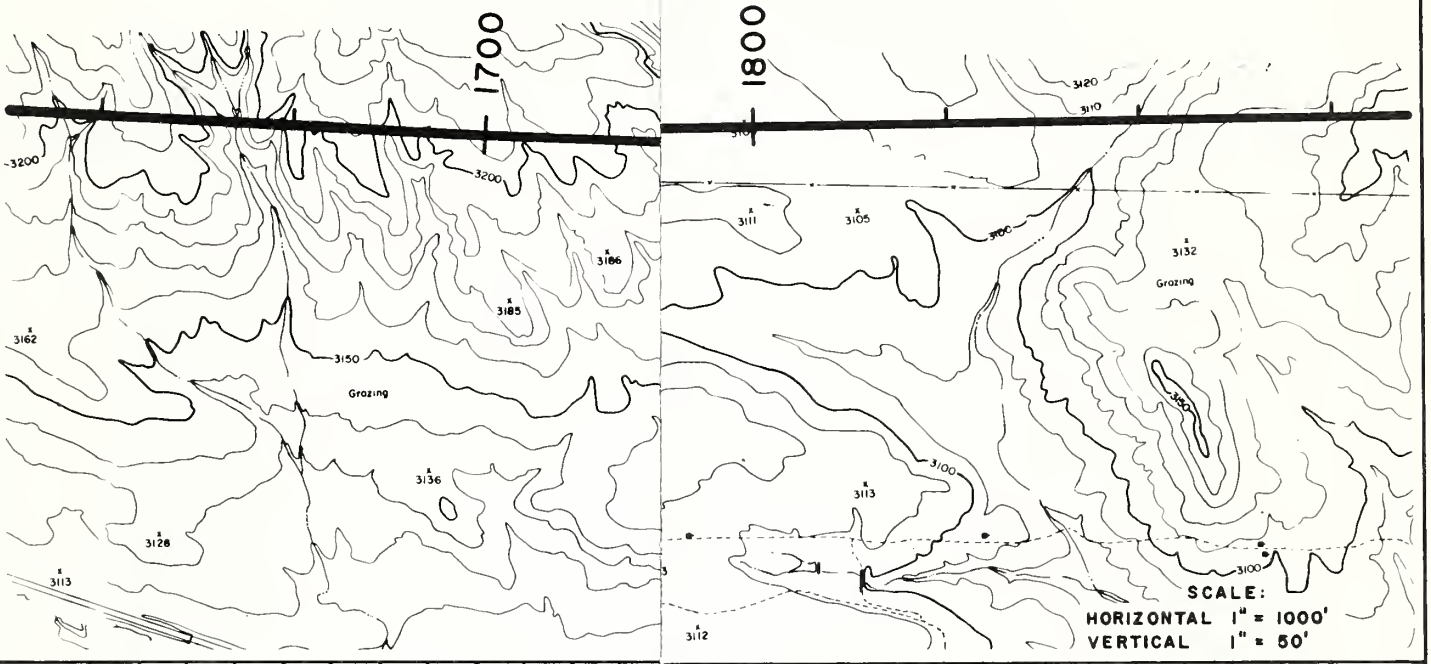
THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

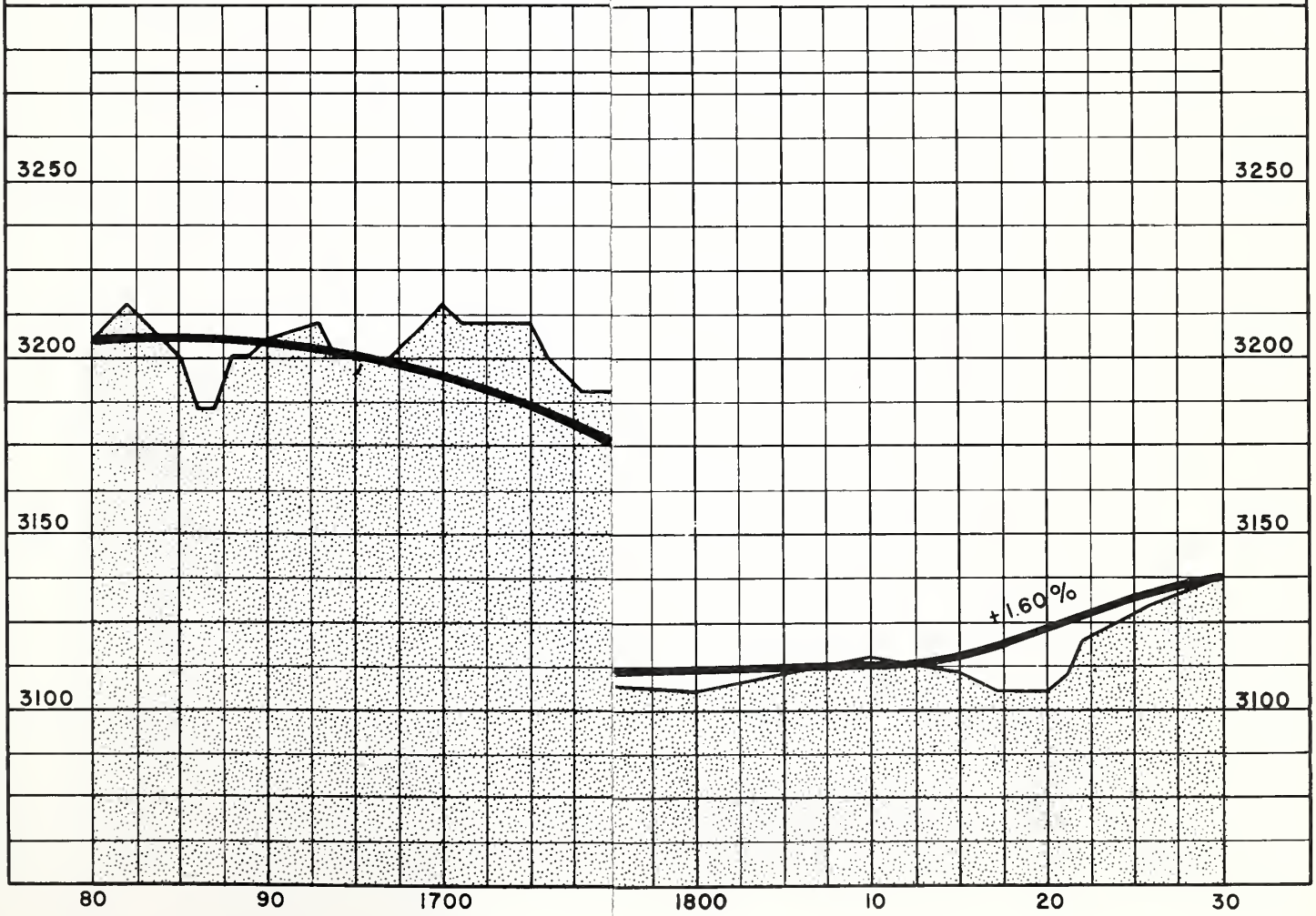




PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	12	17

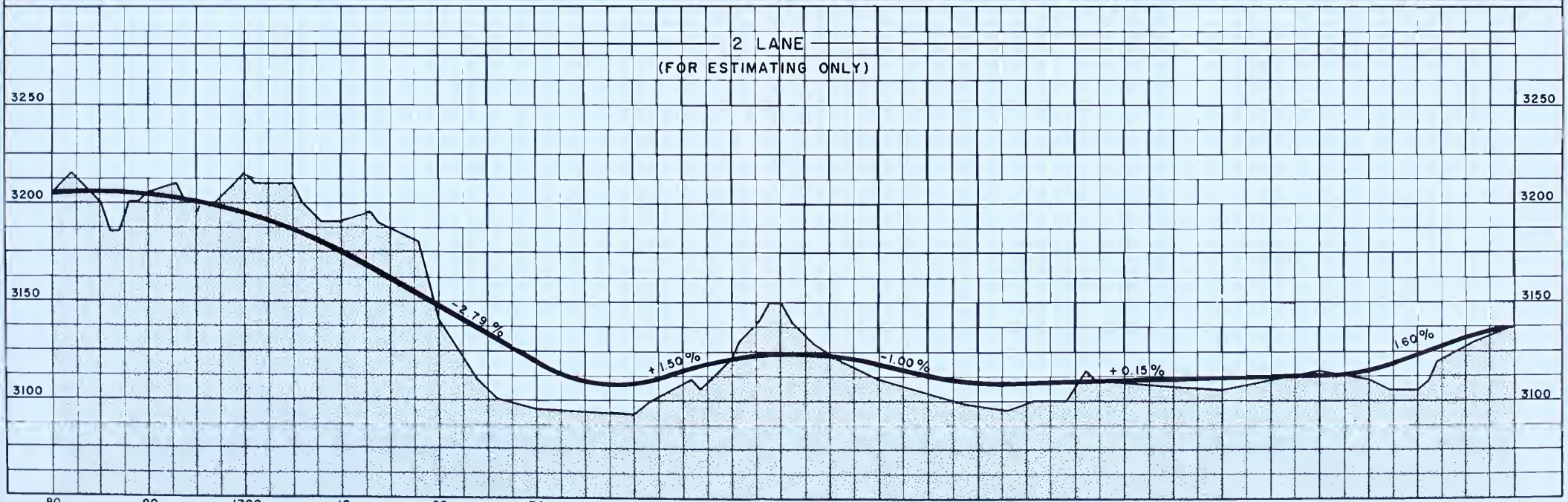
THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO



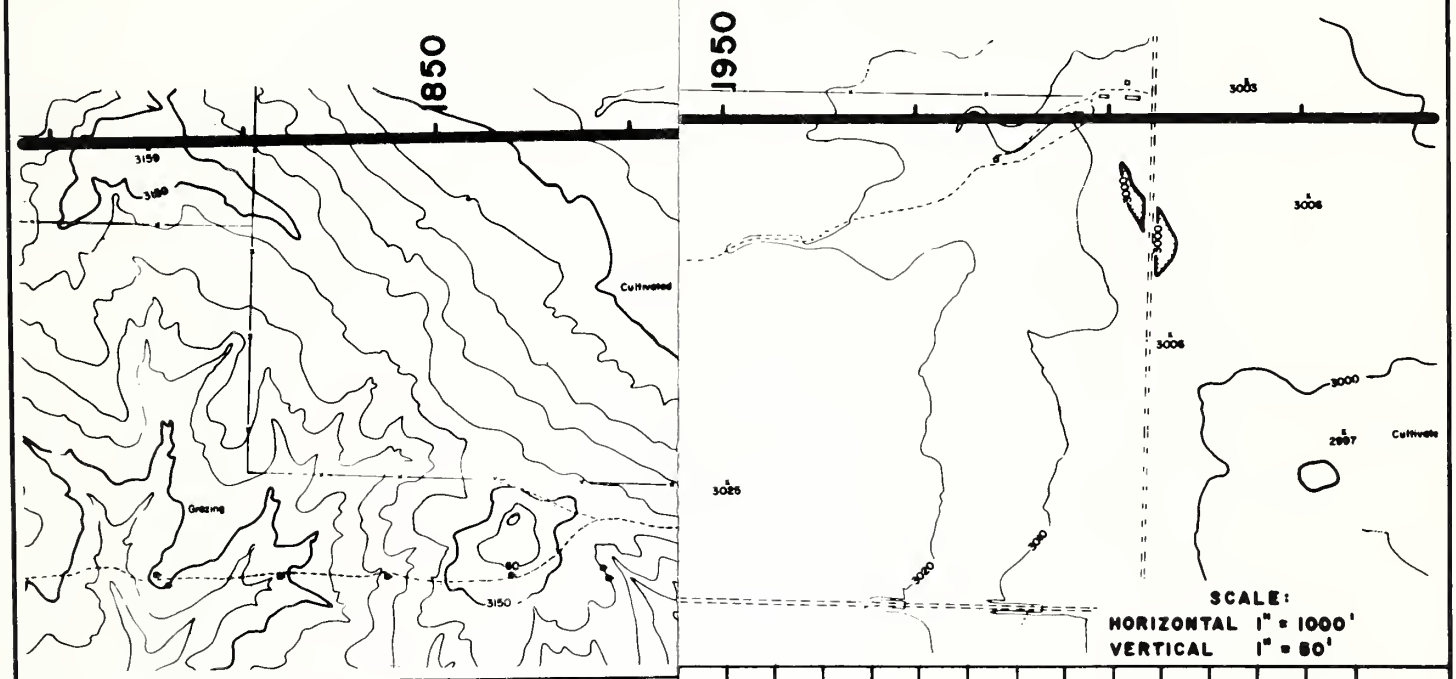


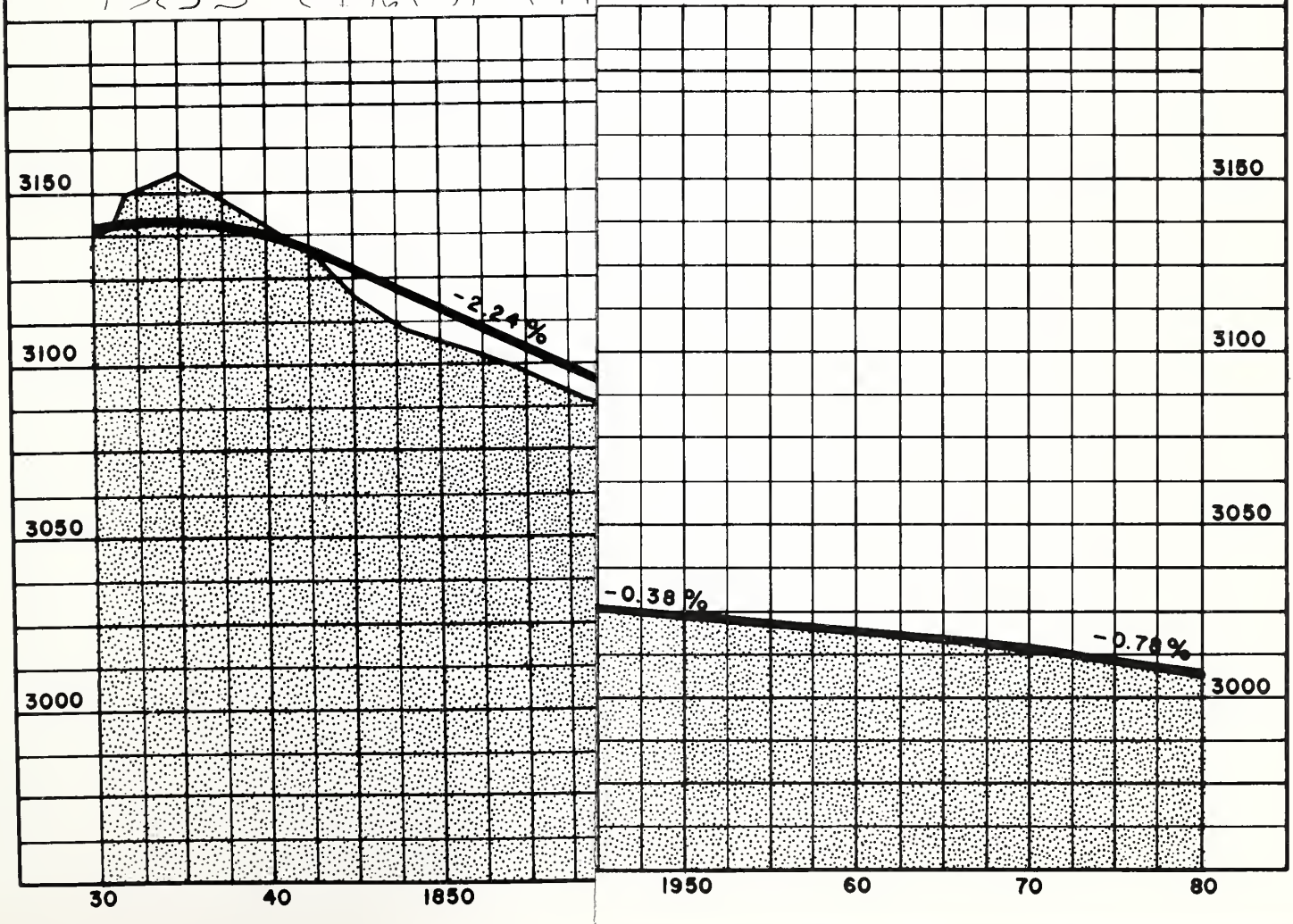
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	12	17

THE KEN R. WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

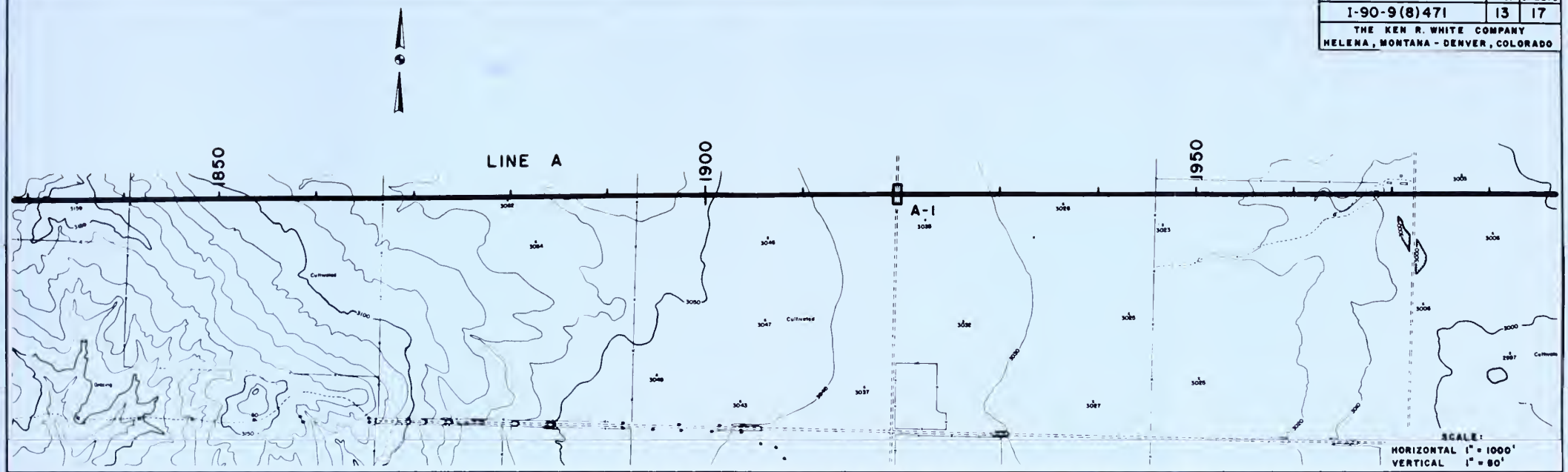


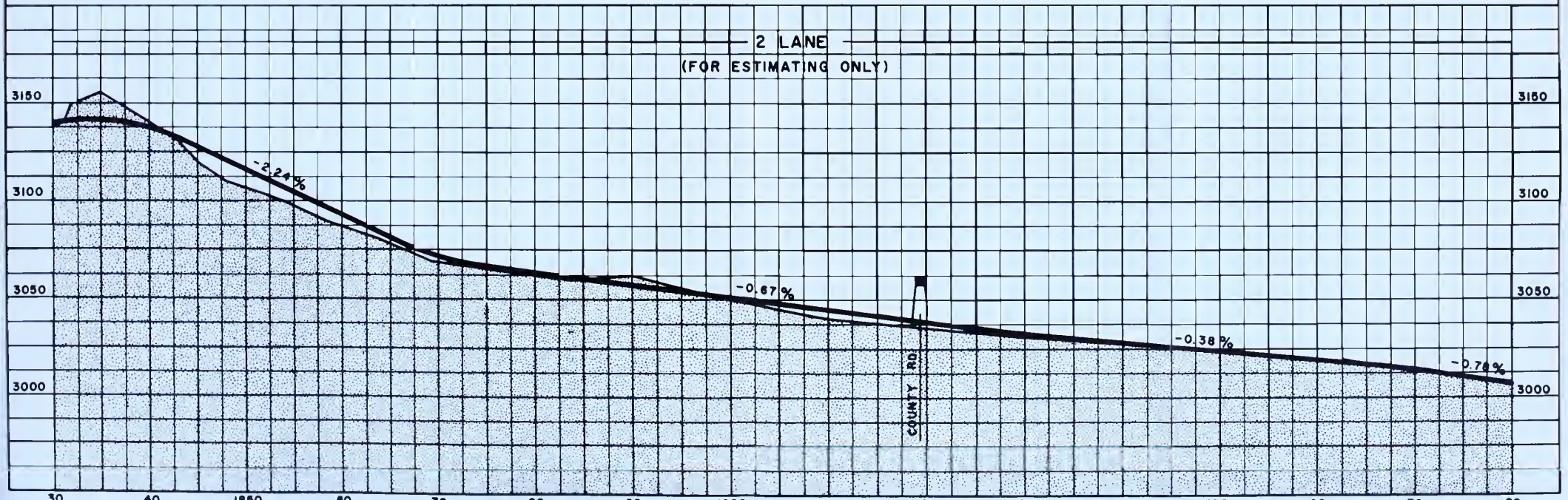
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	13	17
THE KEN R. WHITE COMPANY HELENA, MONTANA - DENVER, COLORADO		





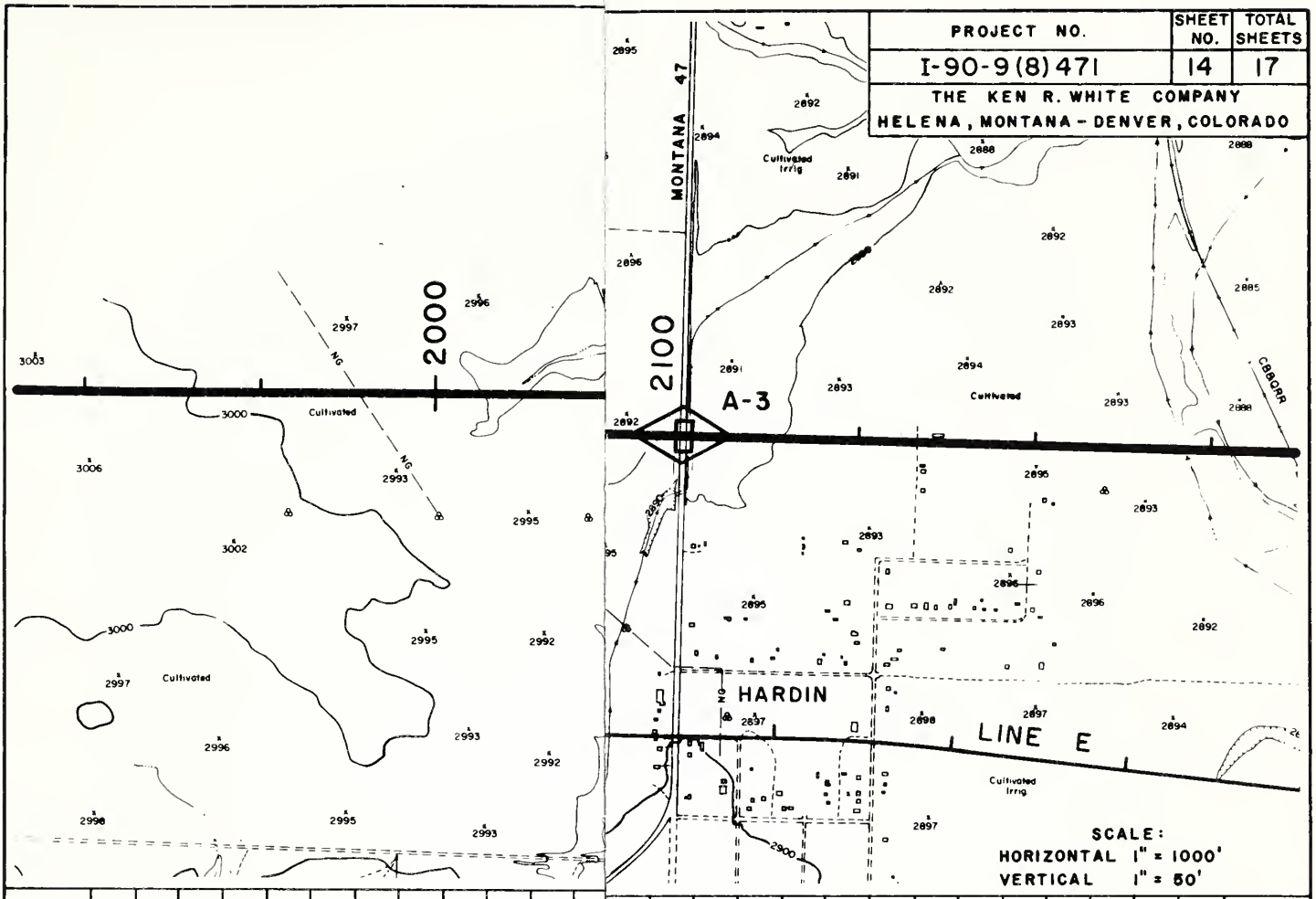
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	13	17
THE KEN R. WHITE COMPANY HELENA, MONTANA - DENVER, COLORADO		

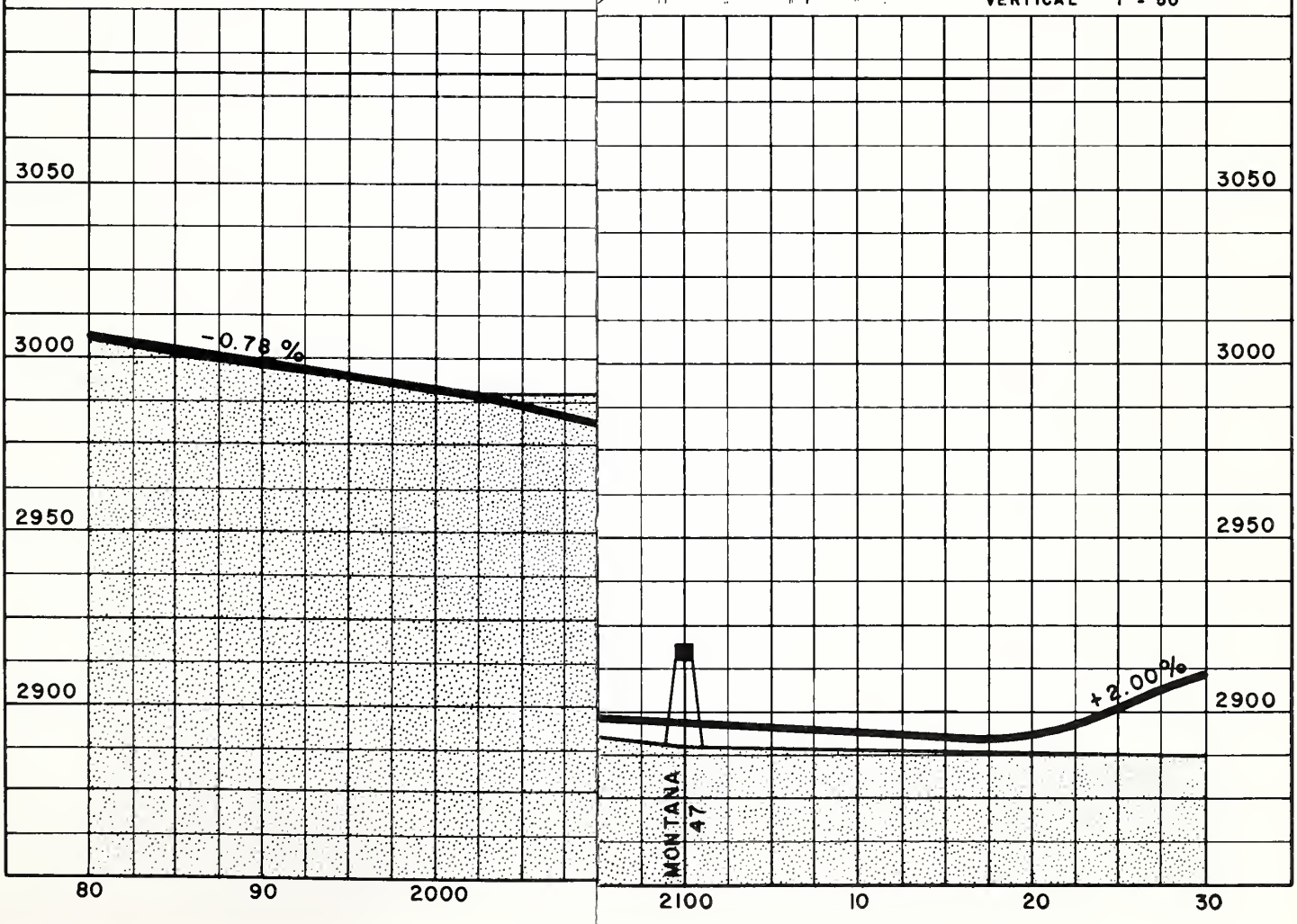




PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	14	17

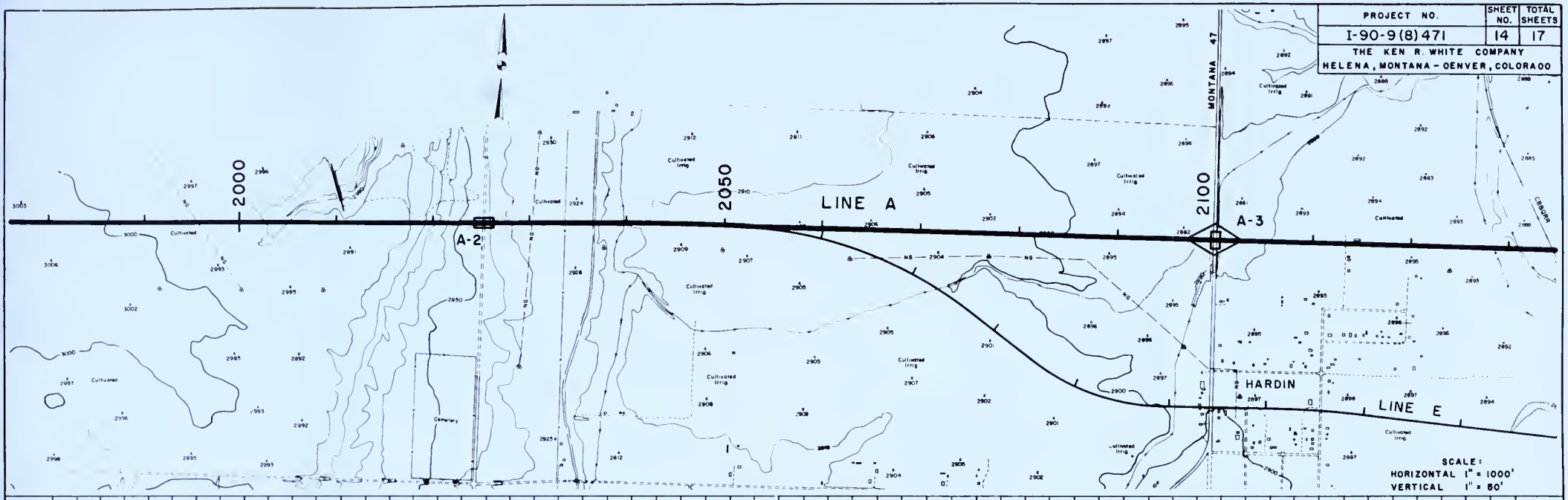
THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO

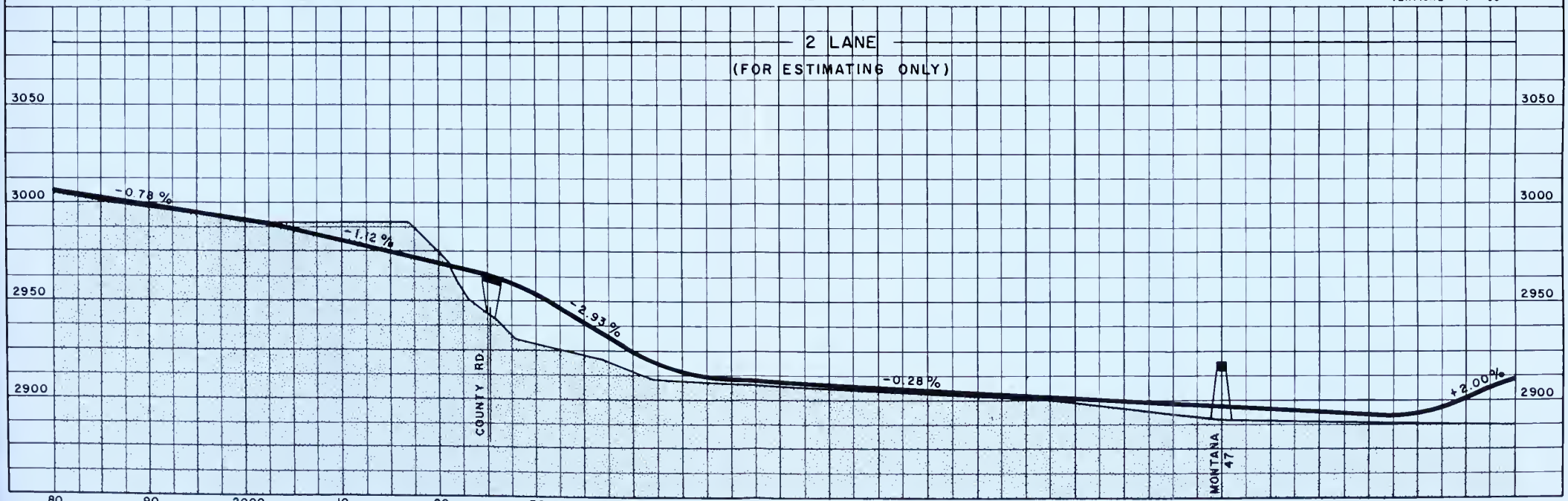




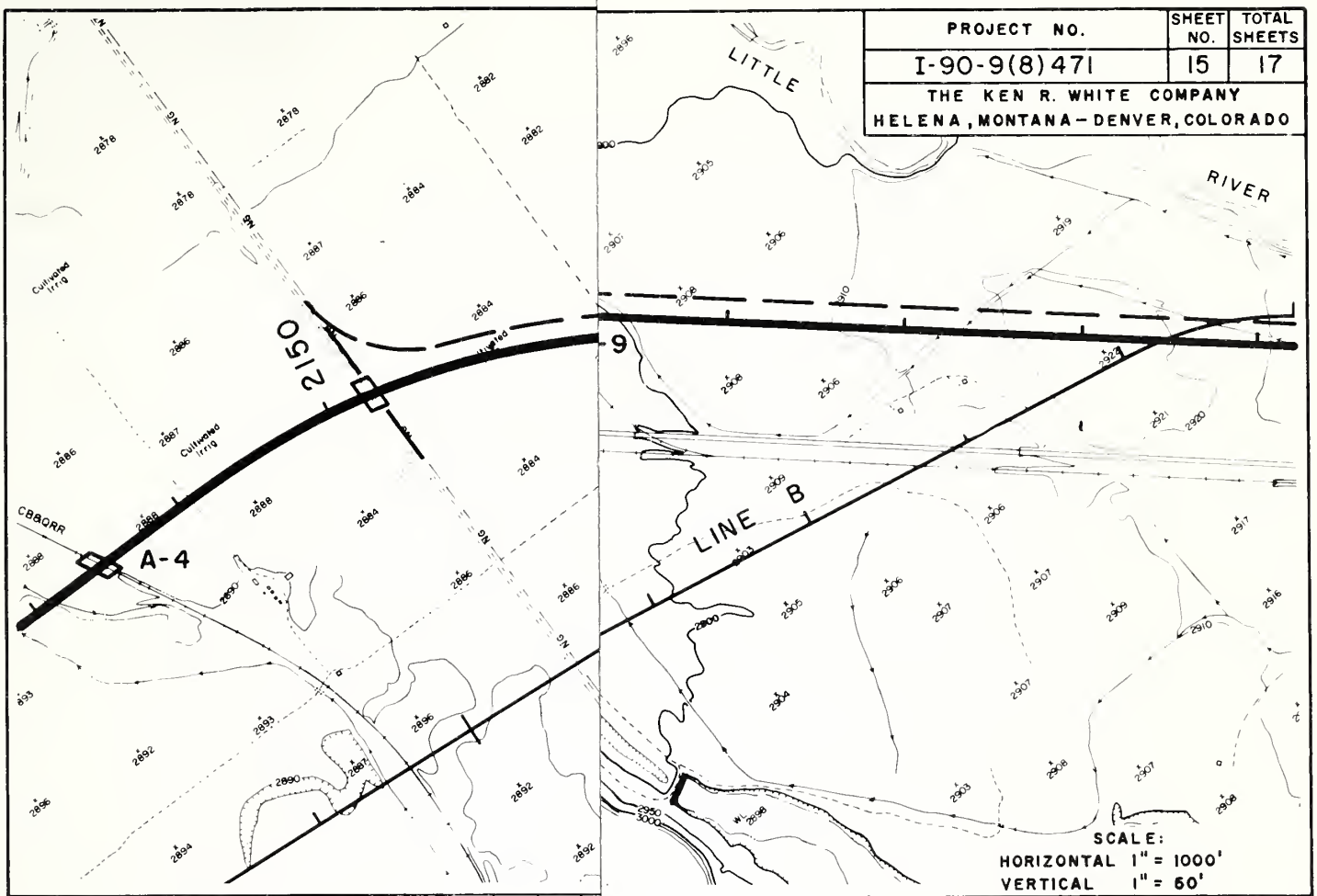
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	14	17

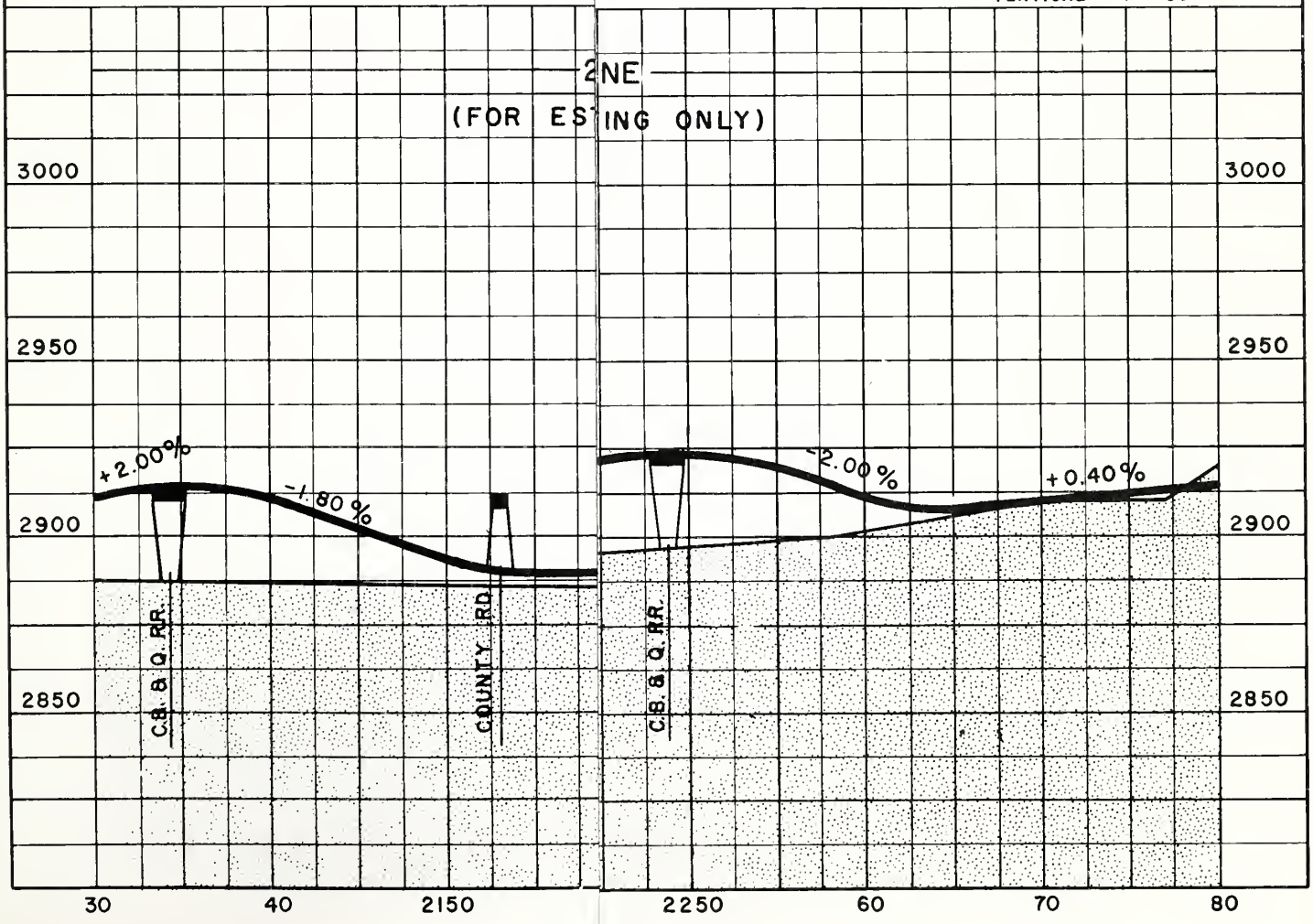
THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO





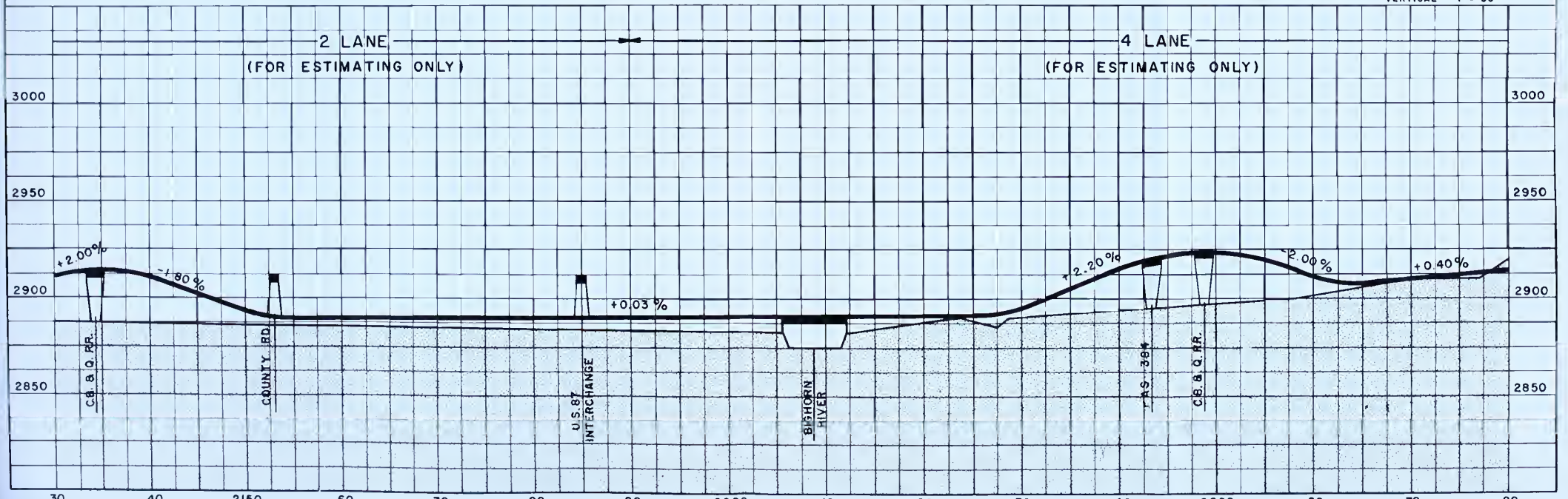
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	15	17
THE KEN R. WHITE COMPANY HELENA, MONTANA – DENVER, COLORADO		





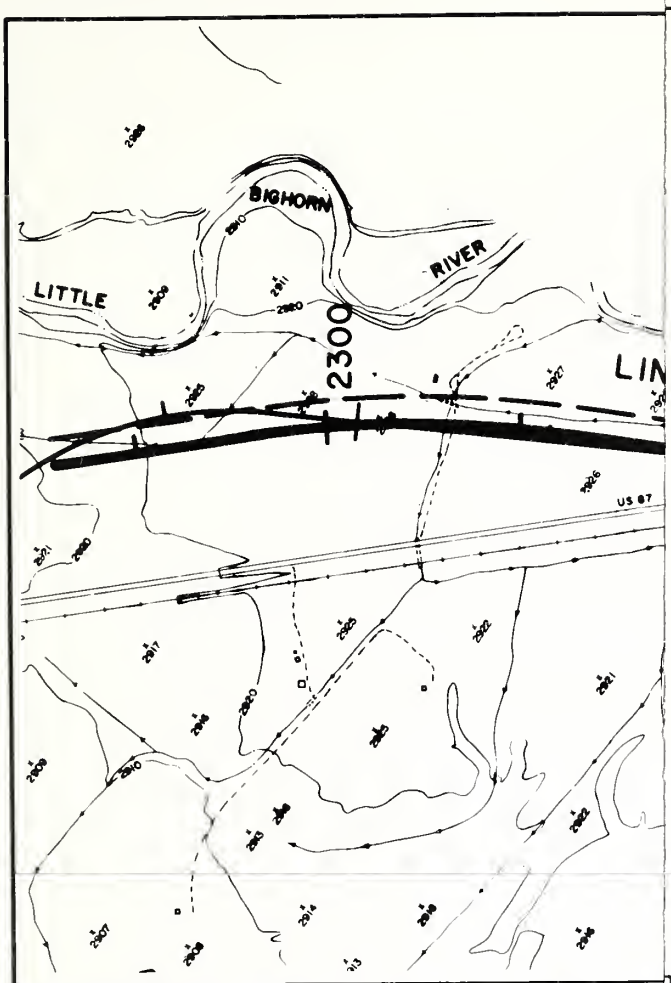
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	15	17

THE KEN R WHITE COMPANY
HELENA, MONTANA – DENVER, COLORADO

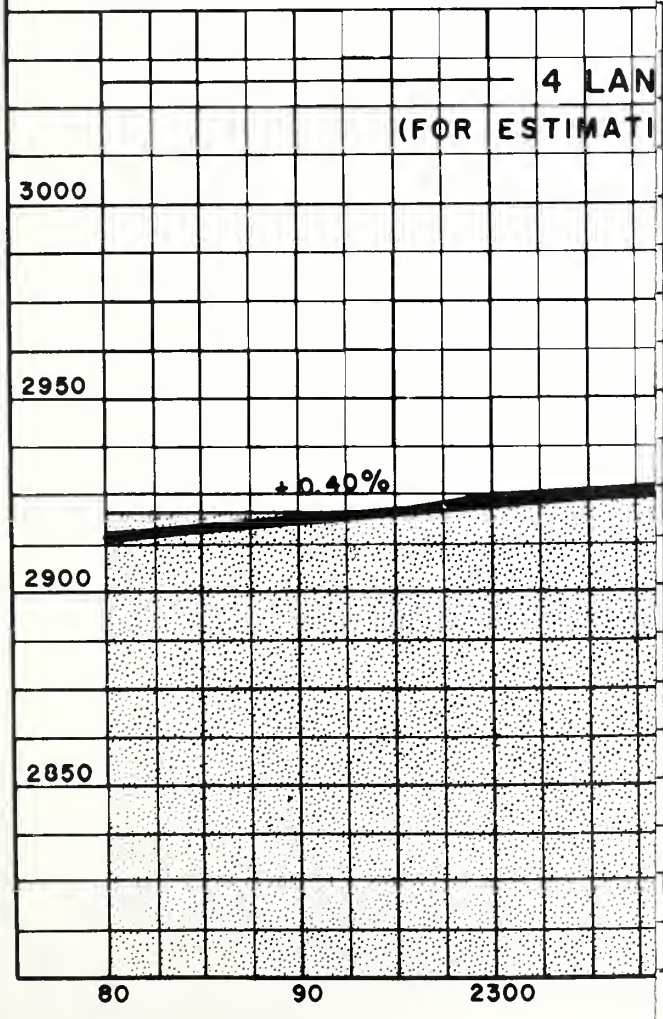


PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	16	17

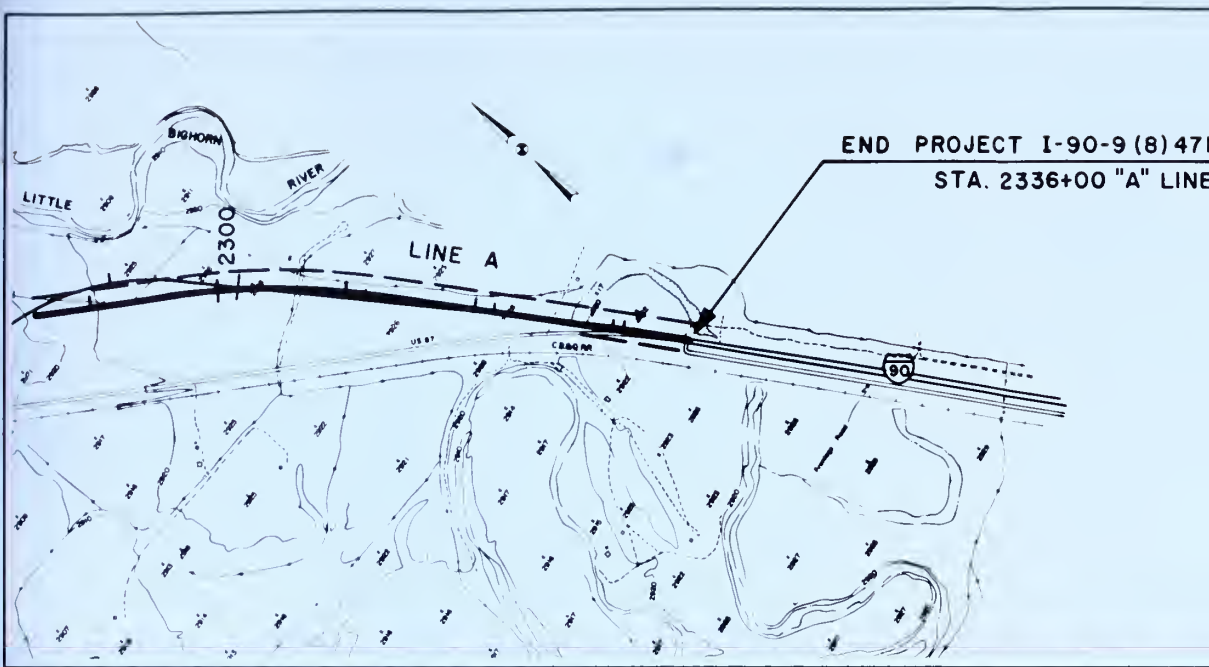
THE KEN R. WHITE COMPANY
HELENA, MONTANA - DENVER, COLORADO



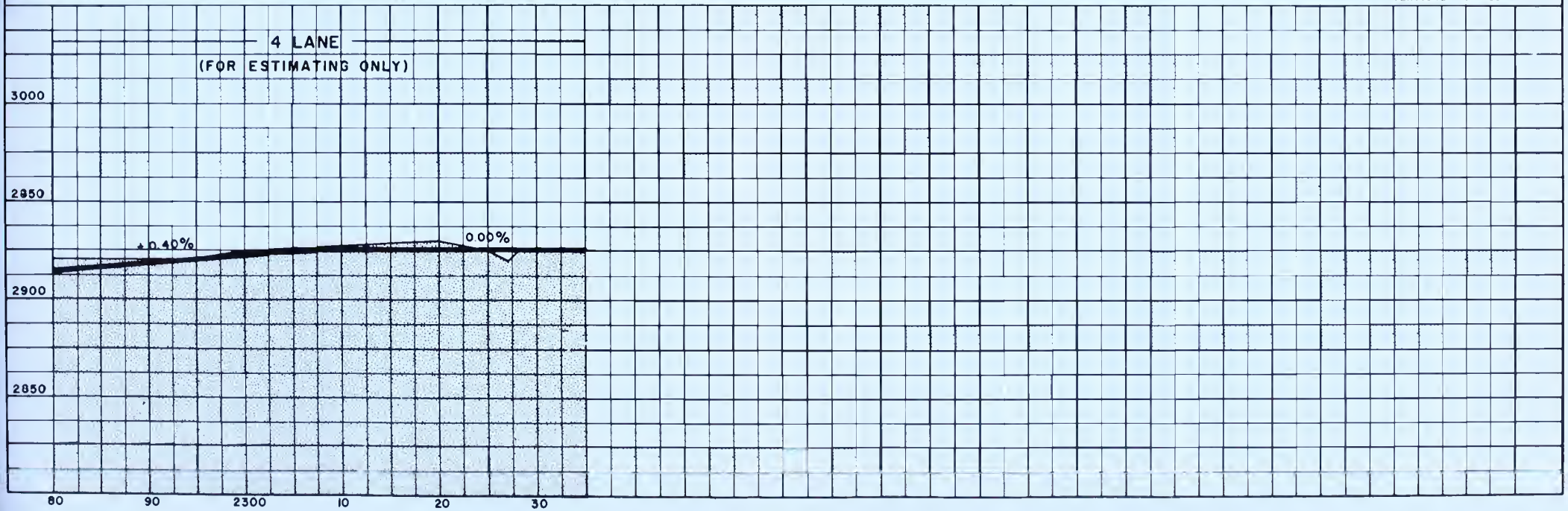
SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'



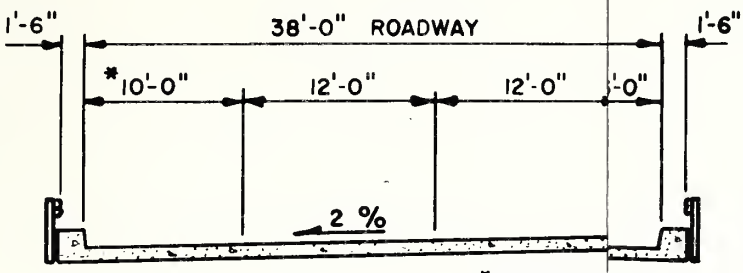
PROJECT NO.	SHEET NO.	TOTAL SHEETS
I-90-9(8)471	16	17
THE KEN R. WHITE COMPANY HELENA, MONTANA - DENVER, COLORADO		



SCALE:
HORIZONTAL 1" = 1000'
VERTICAL 1" = 50'

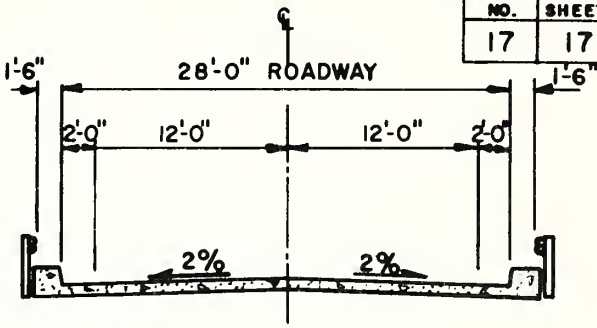


SHEET NO.	TOTAL SHEETS
17	17

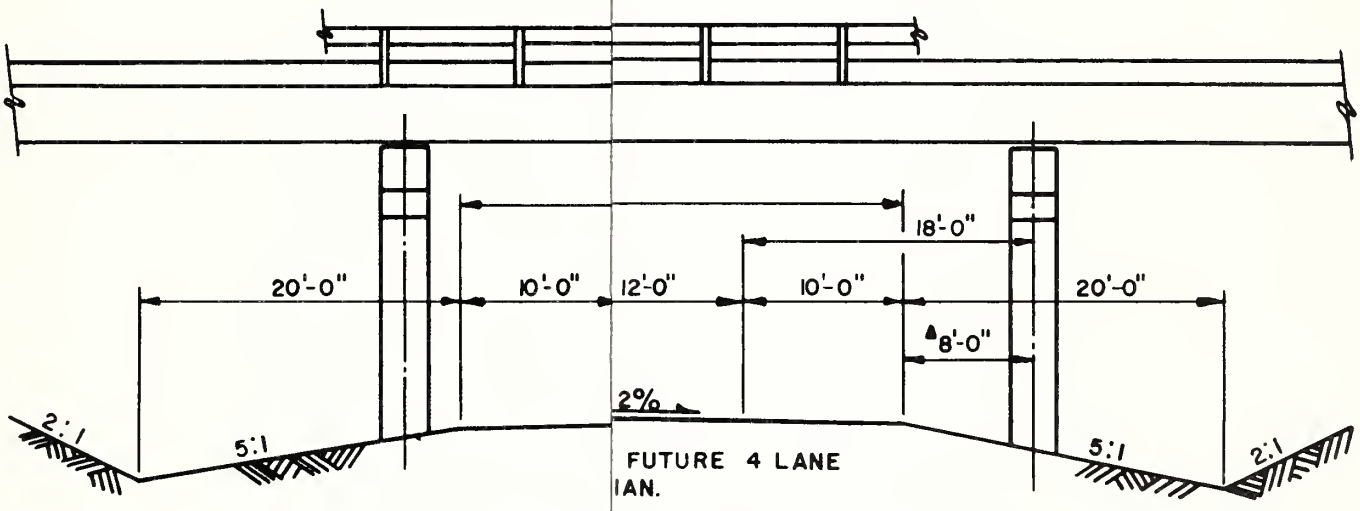


*SHOULDE
REDUCE

FOUR LANE I
(ONE HALF SH

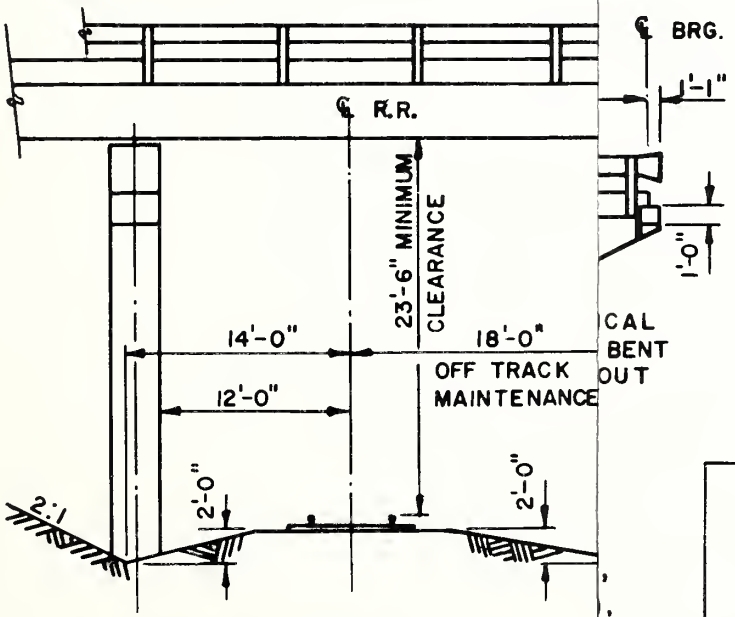


COUNTY ROAD
CENTER AVE.



FUTURE 4 LANE
IAN.

FOUR INTERSTATE
(



CAL
BENT
OUT

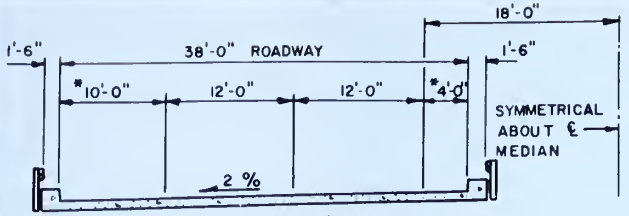
C.B. & Q. R. R.

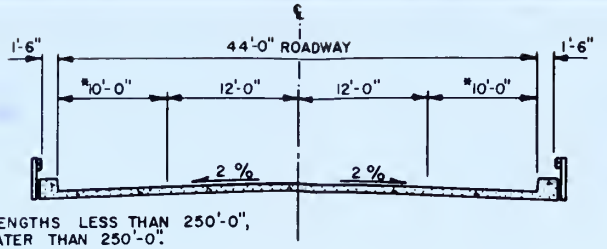
VE.

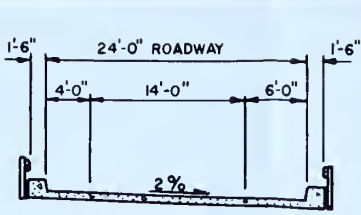
STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

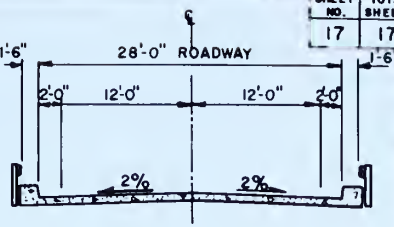
BRIDGE LAYOUT CRITERIA

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO









*SHOULDER WIDTHS AS SHOWN FOR LENGTHS LESS THAN 250'-0", REDUCE TO 2'-0" FOR LENGTHS GREATER THAN 250'-0".

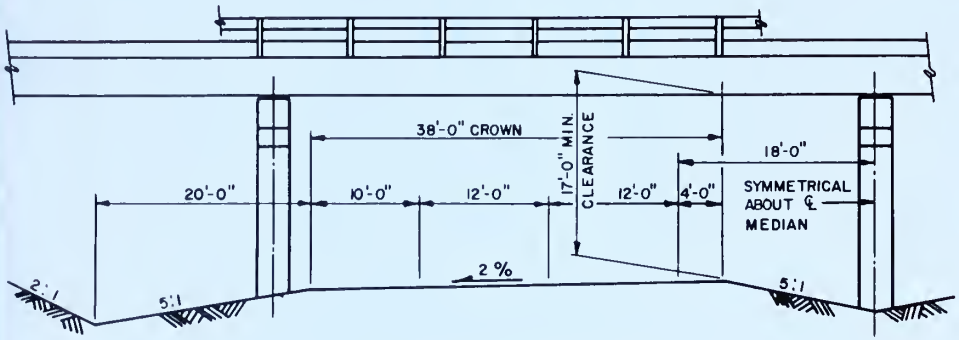
FOUR LANE INTERSTATE
(ONE HALF SHOWN)

TWO LANE INTERSTATE

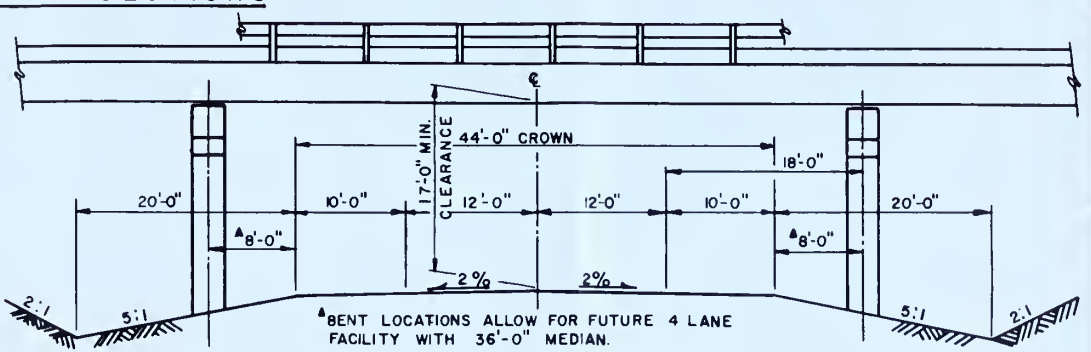
RAMP

COUNTY ROAD
CENTER AVE.

OVERPASS SECTIONS

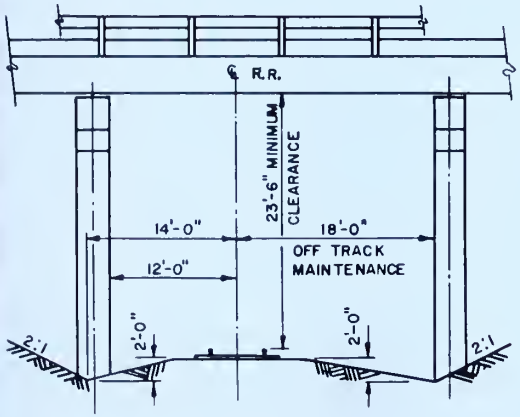


FOUR LANE INTERSTATE
(ONE HALF SHOWN)

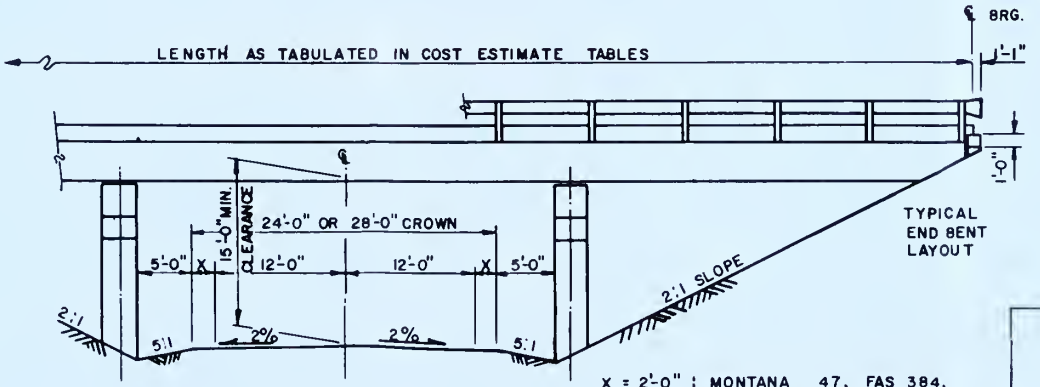


▲BENT LOCATIONS ALLOW FOR FUTURE 4 LANE FACILITY WITH 36'-0" MEDIAN.

TWO LANE INTERSTATE



C.B. & Q. R.R.



LOCAL ROADS

X = 2'-0" : MONTANA 47, FAS 384, FAS 313 (MITCHELL AVE), U.S. 87, AND CENTER AVE.
X = 0'-0" : COUNTY ROADS.

UNDERPASS SECTIONS

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

BRIDGE LAYOUT CRITERIA

THE KEN R. WHITE COMPANY
HELENA, MONTANA ——— DENVER, COLORADO